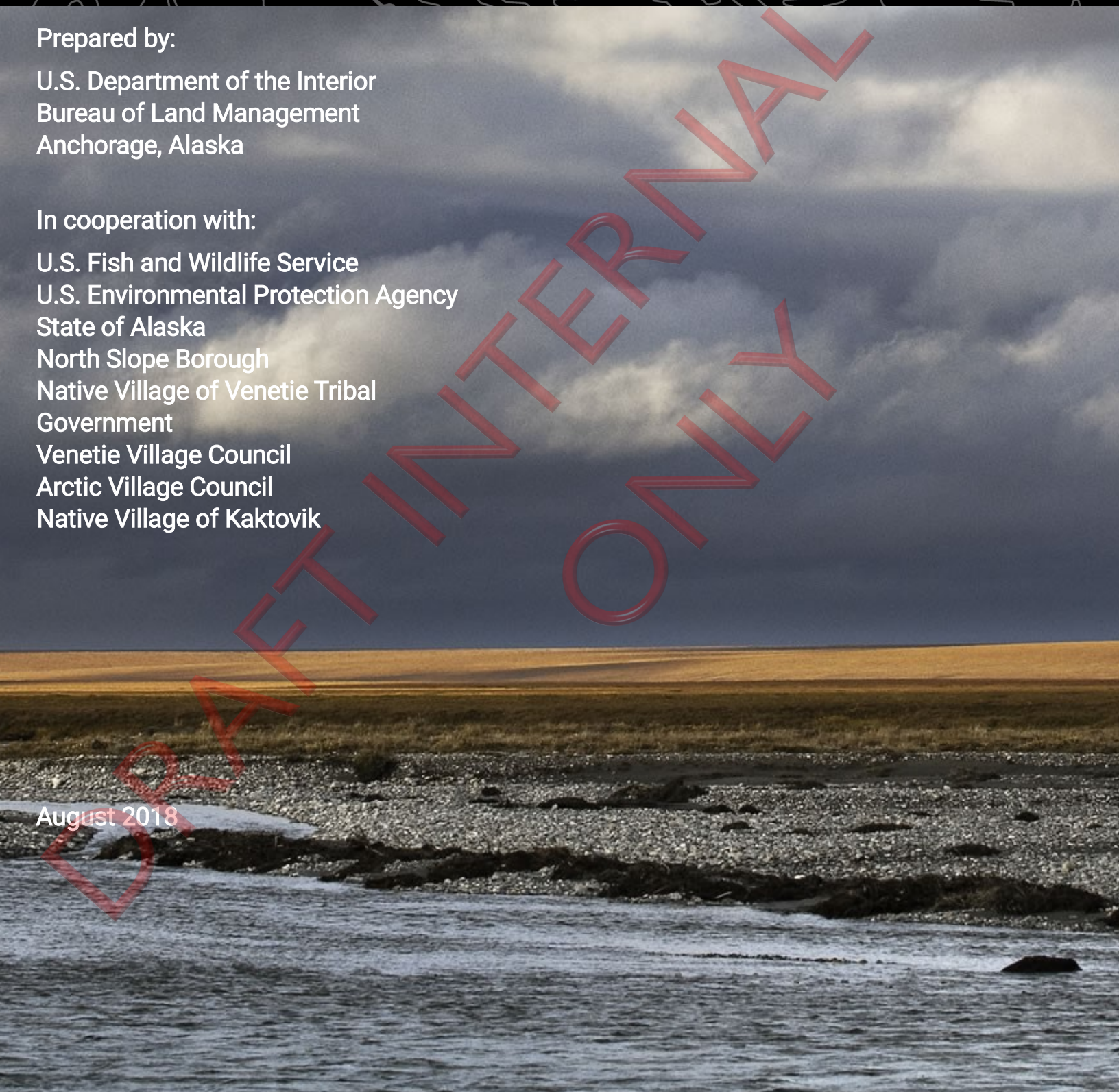
U.S. Department of the Interior
Bureau of Land Management

Coastal Plain Oil and Gas Leasing Program Draft Environmental Impact Statement

Volume II: Appendices



Prepared by:

U.S. Department of the Interior
Bureau of Land Management
Anchorage, Alaska

In cooperation with:

U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
State of Alaska
North Slope Borough
Native Village of Venetie Tribal Government
Venetie Village Council
Arctic Village Council
Native Village of Kaktovik

August 2018

The Bureau of Land Management's multiple-use mission is to sustain the health and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau accomplishes this by managing such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and by conserving natural, historical, cultural, and other resources on public lands.

Cover Photo: Jeff Jones

APPENDICES

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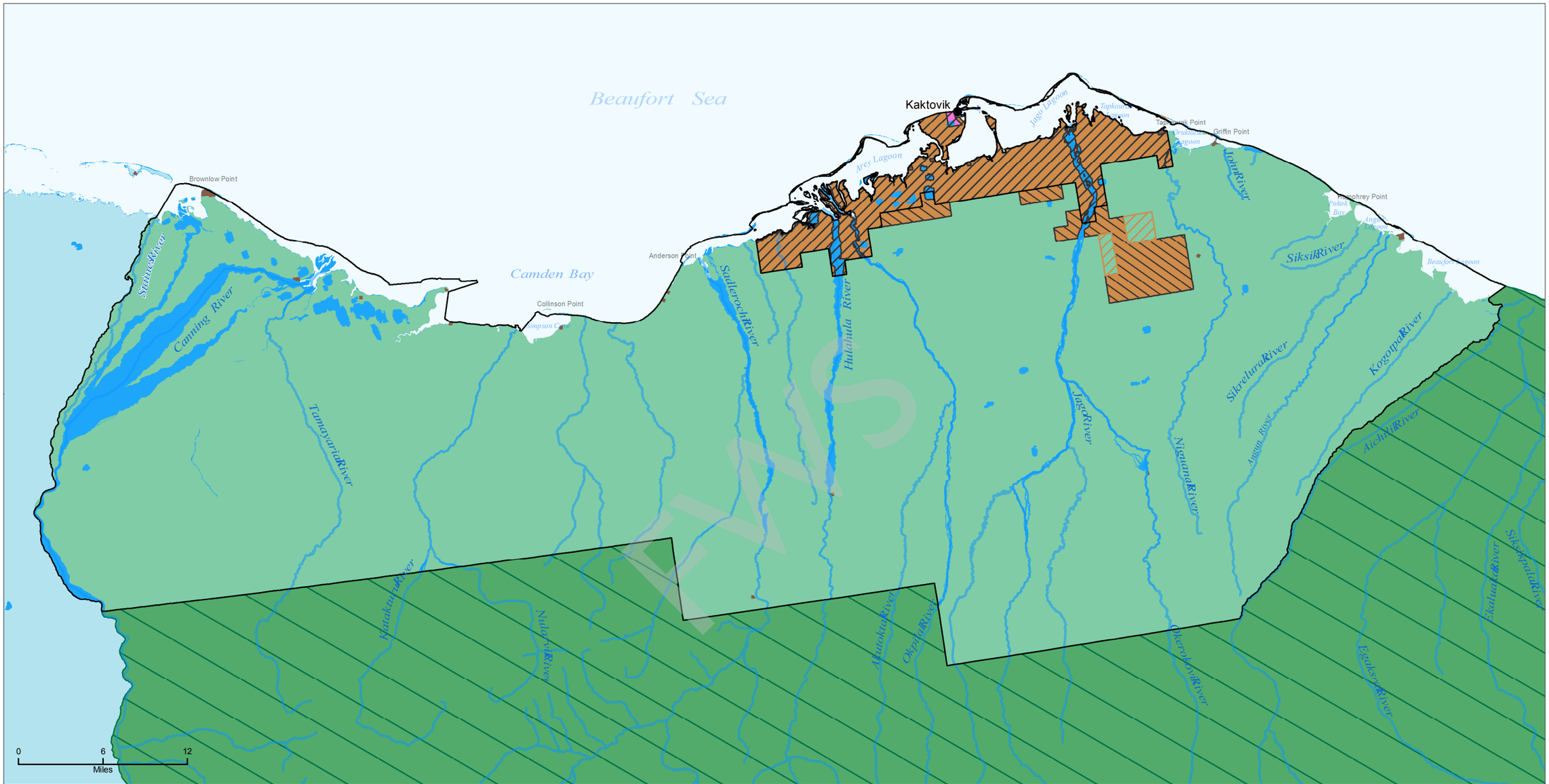
Appendix A
Maps and Figures

APPENDIX A
Maps

APPENDIX A

Figures



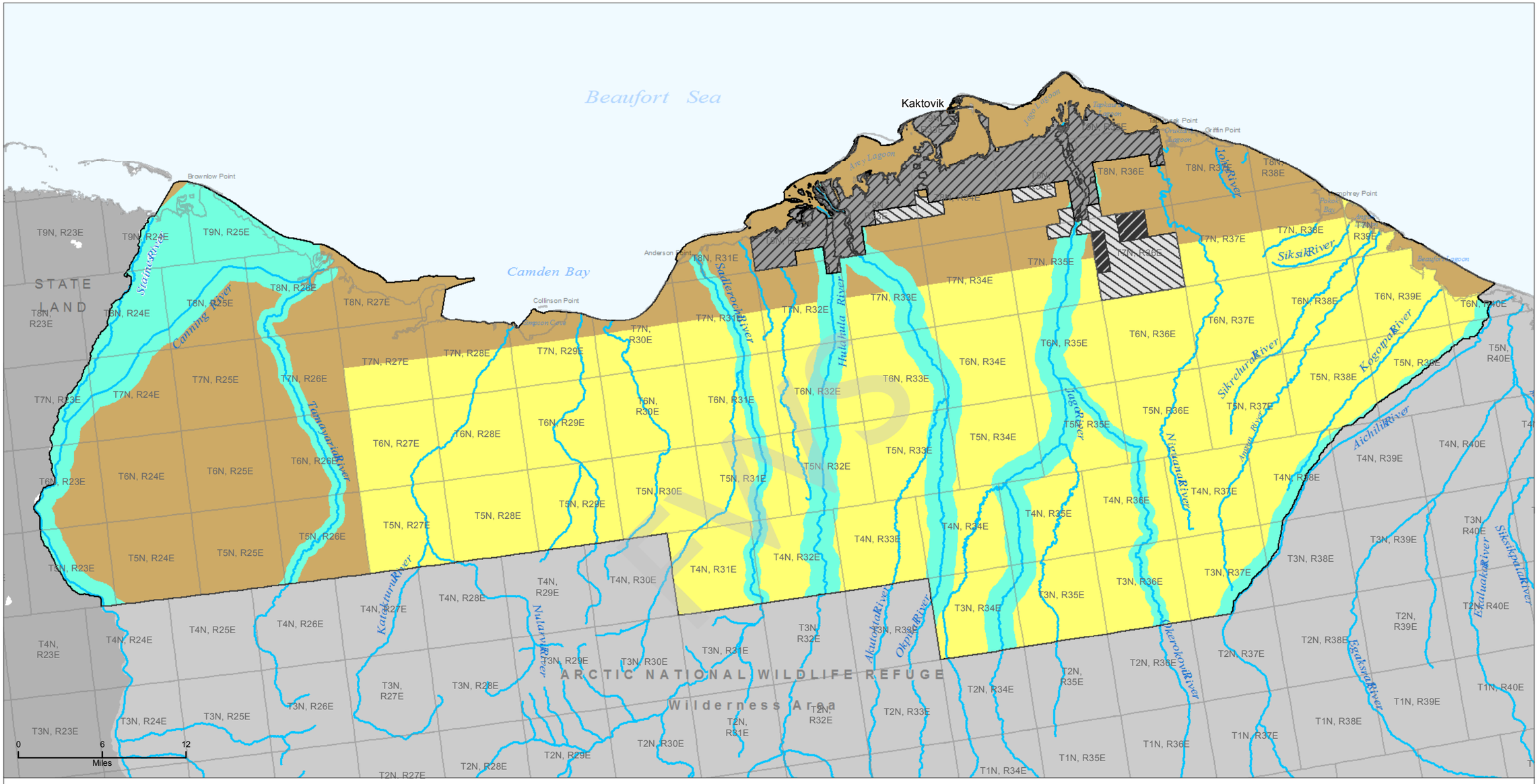
- U.S. Fish and Wildlife Service
- U.S. Fish and Wildlife Service, wilderness area
- Native lands (patented or interim conveyed)
- State
- Air Force
- Native allotment
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018
Print Date: 08/08/2018

Map 1-1



Not offered for lease sale (none)

Available for lease sale:

- Subject to no surface occupancy
- Subject to controlled surface use (none)
- Subject to timing limitations
- Subject to standard terms and conditions

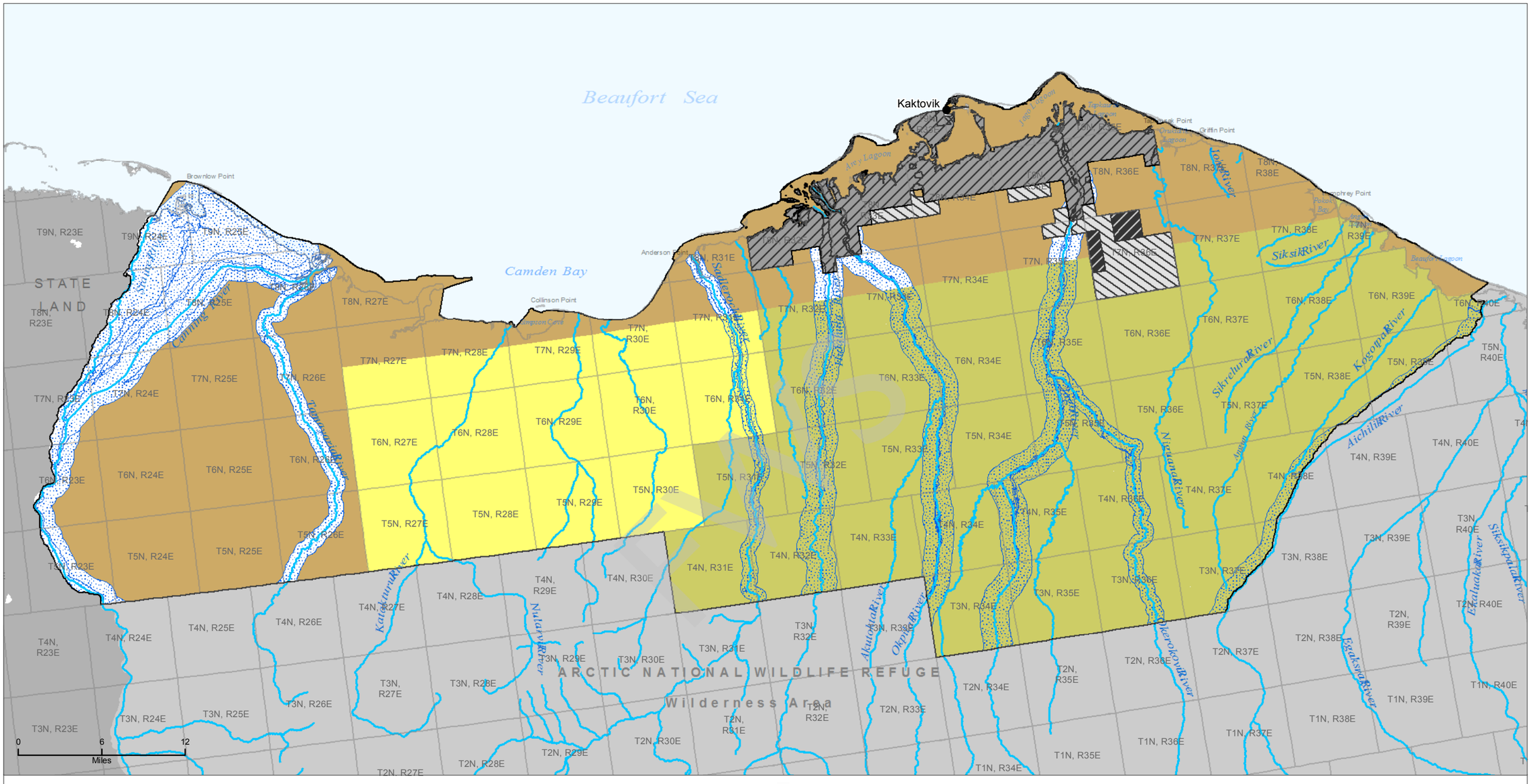
Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-1



Available for lease sale, subject to no surface occupancy

- Lease stipulation 1—rivers and streams

Available for lease sale, subject to timing limitations

- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 8—porcupine caribou post-calving habitat

Available for lease sale

- Subject to standard terms and conditions

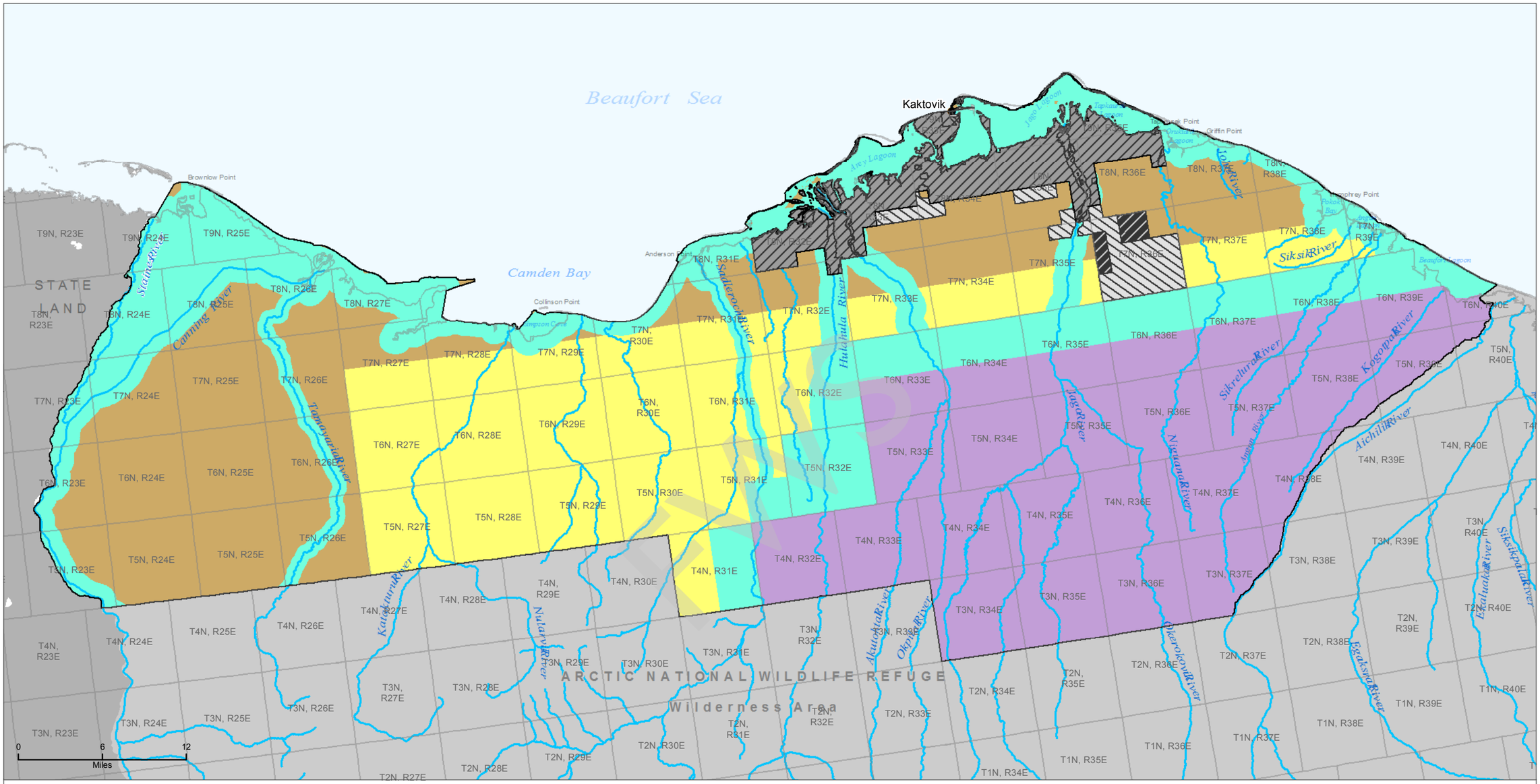
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-2



- Not offered for lease sale

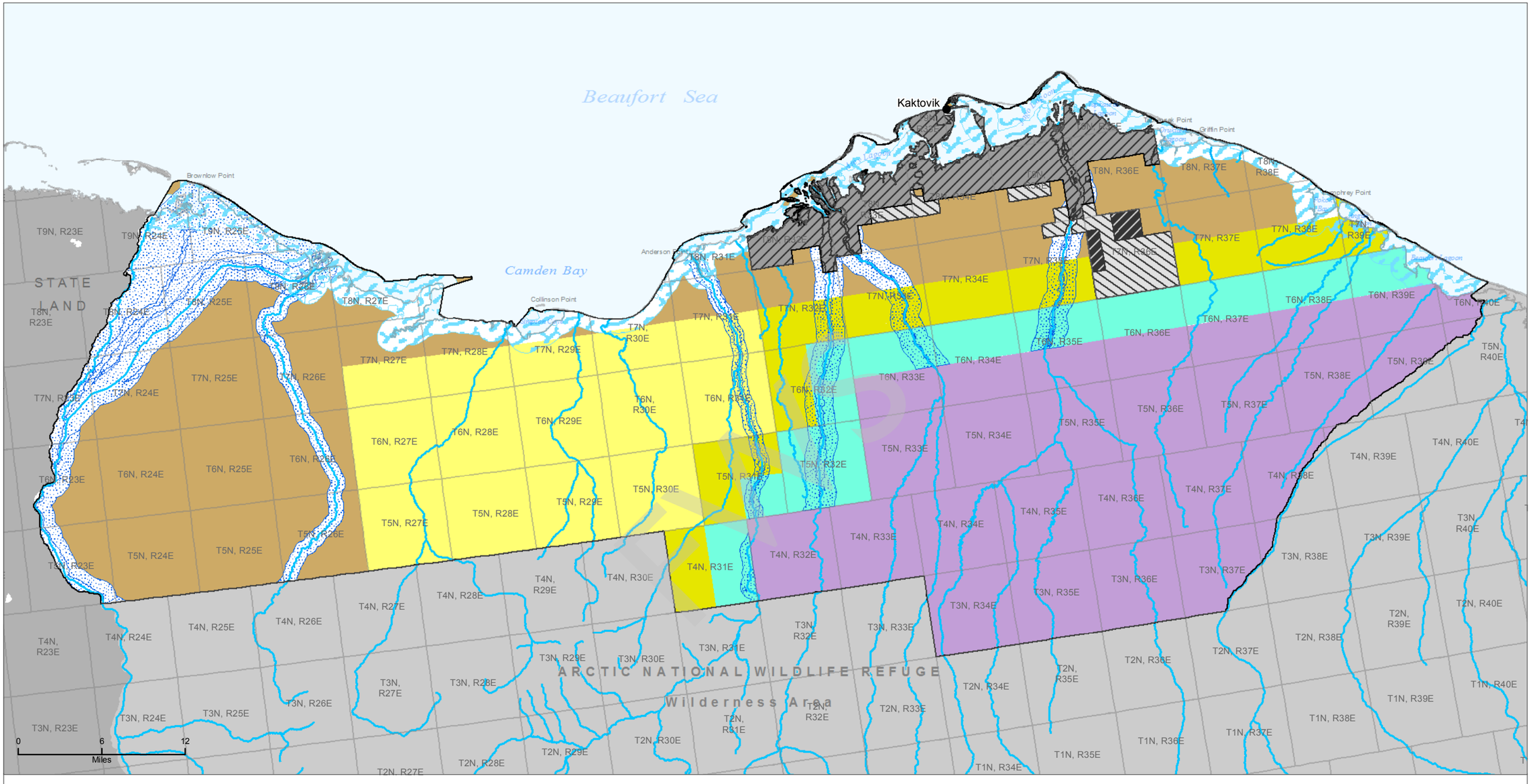
Available for lease sale:
- Subject to no surface occupancy
- Subject to controlled surface use (none)
- Subject to timing limitations
- Subject to standard terms and conditions

- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-3



Not offered for lease sale and not available for surface occupancy

- Lease stipulation 7—porcupine caribou calving habitat

Available for lease sale, subject to no surface occupancy

- Lease stipulation 1—rivers and streams
- Lease stipulation 9—coastal area
- Lease stipulation 7—porcupine caribou calving habitat

Available for lease sale, subject to timing limitations

- Lease stipulation 4—nearshore marine, lagoon, and barrier island habitat
- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 8—porcupine caribou post-calving habitat

Available for lease sale

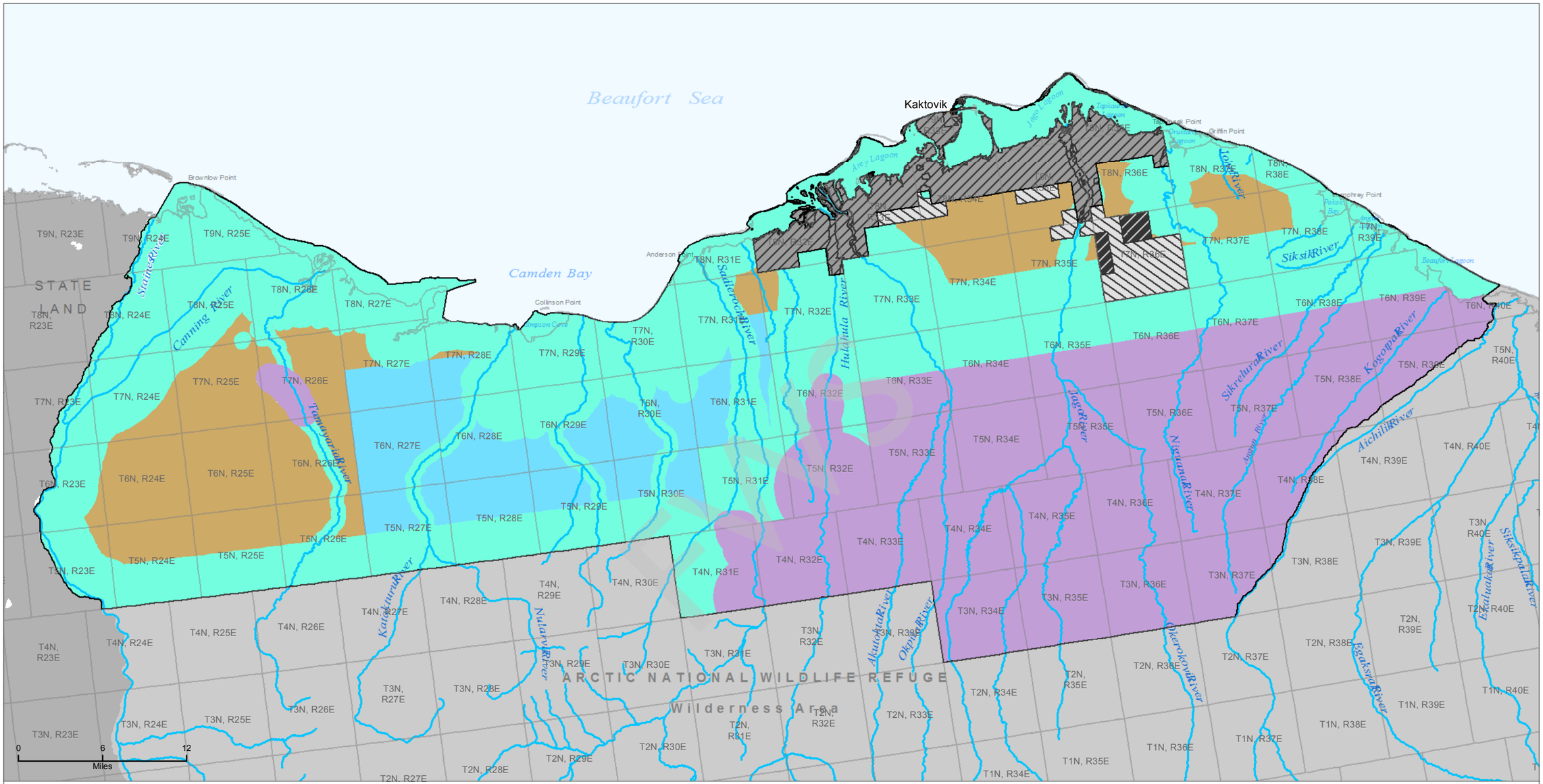
- Subject to standard terms and conditions
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

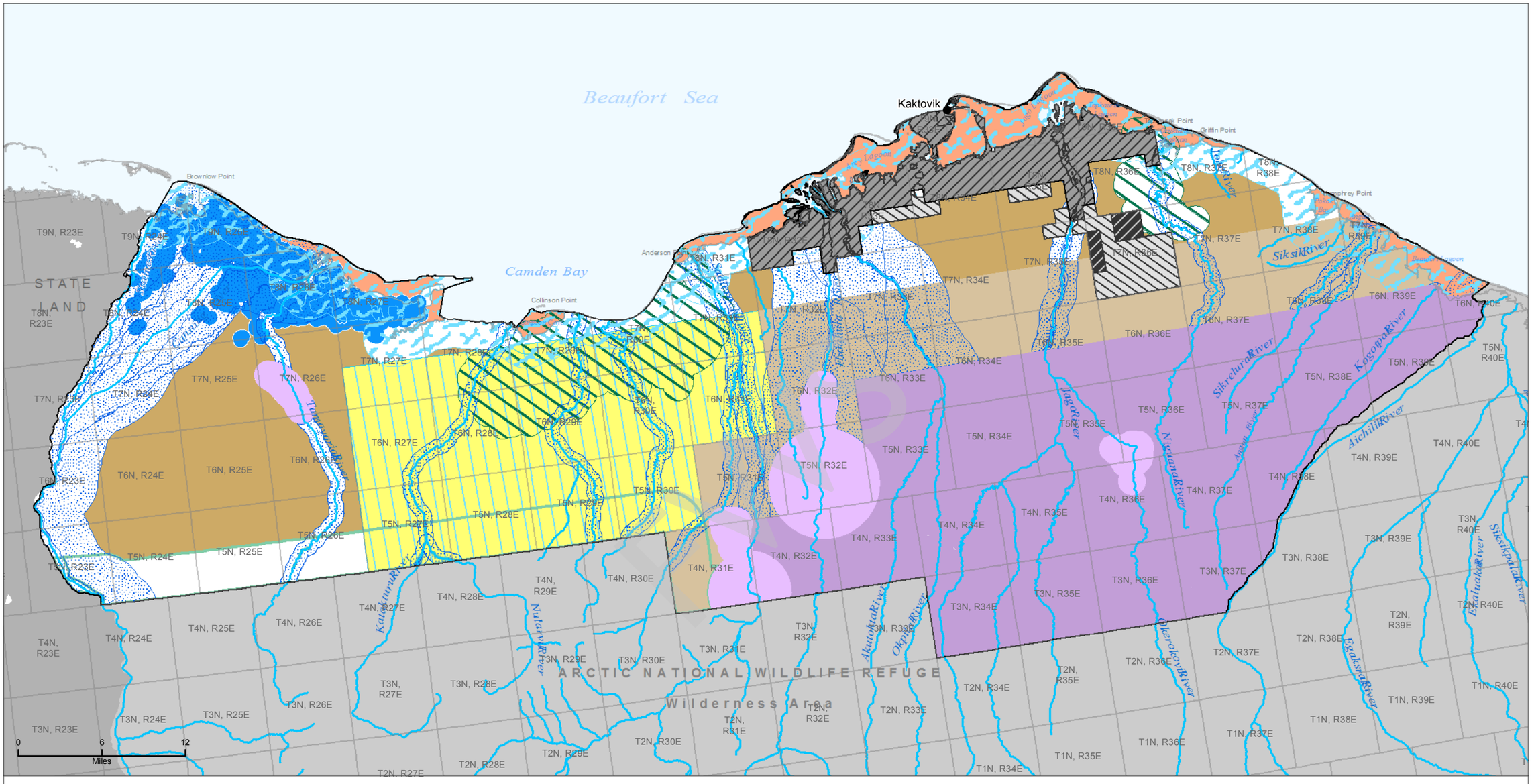
Map 2-4



- Not offered for lease sale
- Available for lease sale:
  - Subject to no surface occupancy
  - Subject to controlled surface use
  - Subject to timing limitations (none)
  - Subject to standard terms and conditions
- Public Law 115-97 Coastal Plain
- Outside BLM's oil and gas leasing authority:
  - Excluded from Public Law 115-97 Coastal Plain
  - Native-selected
  - Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-5



Not offered for lease sale and not available for surface occupancy

- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 3—springs/aufeis

Available for lease sale, subject to no surface occupancy

- Lease stipulation 1—rivers and streams
- Lease stipulation 2—Canning River delta and lakes
- Lease stipulation 5—coastal polar bear river denning habitat
- Lease stipulation 9—coastal area
- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 10—Wilderness boundary

Available for lease sale, subject to controlled surface use

- Lease stipulation 8—porcupine caribou post-calving habitat

Available for lease sale, subject to timing limitations

- Lease stipulation 4—nearshore marine, lagoon, and barrier island habitat, exploration

Available for lease sale, subject to timing limitations

- Lease stipulation 8—porcupine caribou post-calving habitat

Available for lease sale:

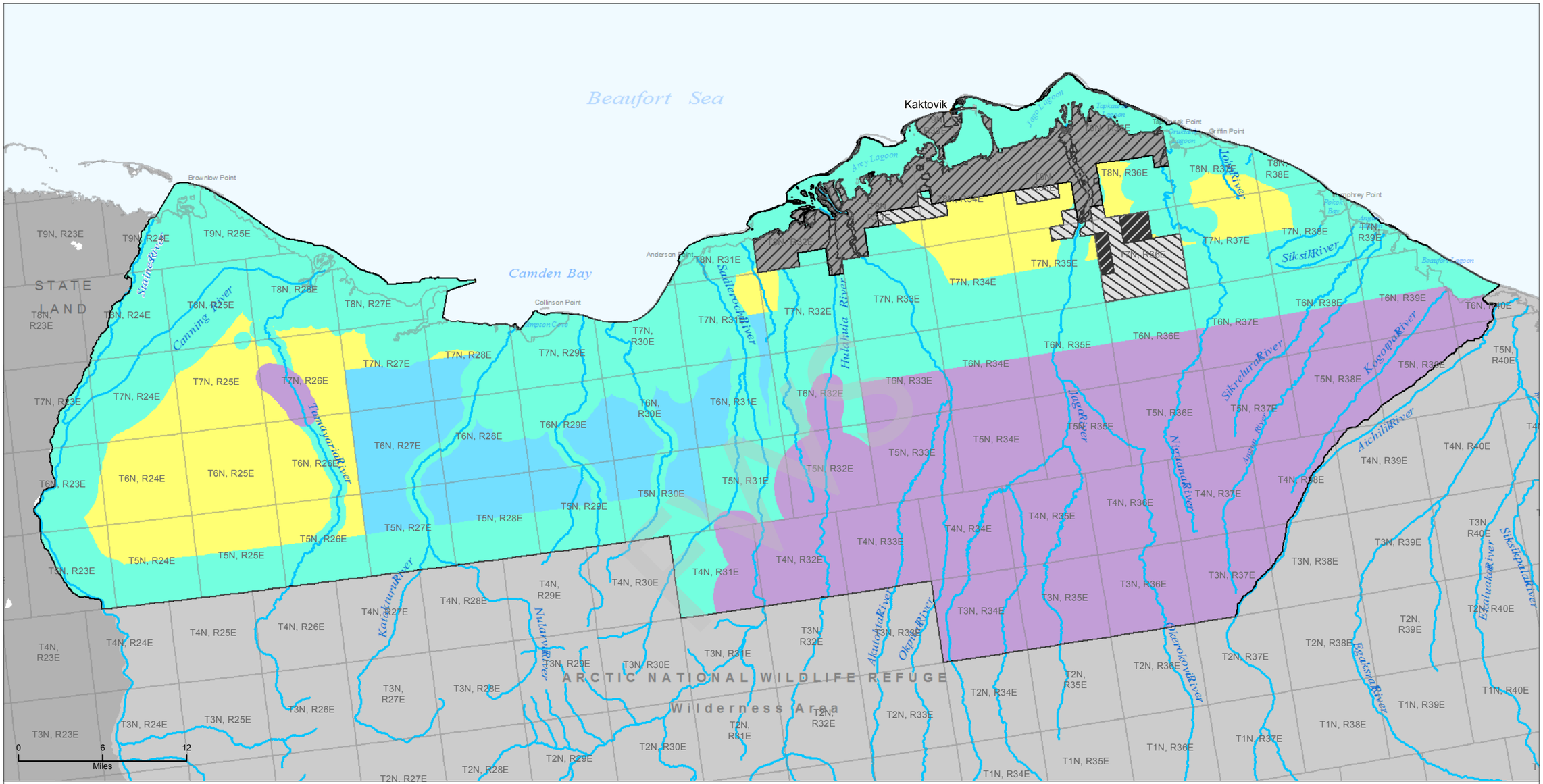
- Subject to standard terms and conditions
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Interim conveyed land
- Native-selected

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-6



Not offered for lease sale

Available for lease sale:

- Subject to no surface occupancy
- Subject to controlled surface use
- Subject to timing limitations
- Subject to standard terms and conditions (none)

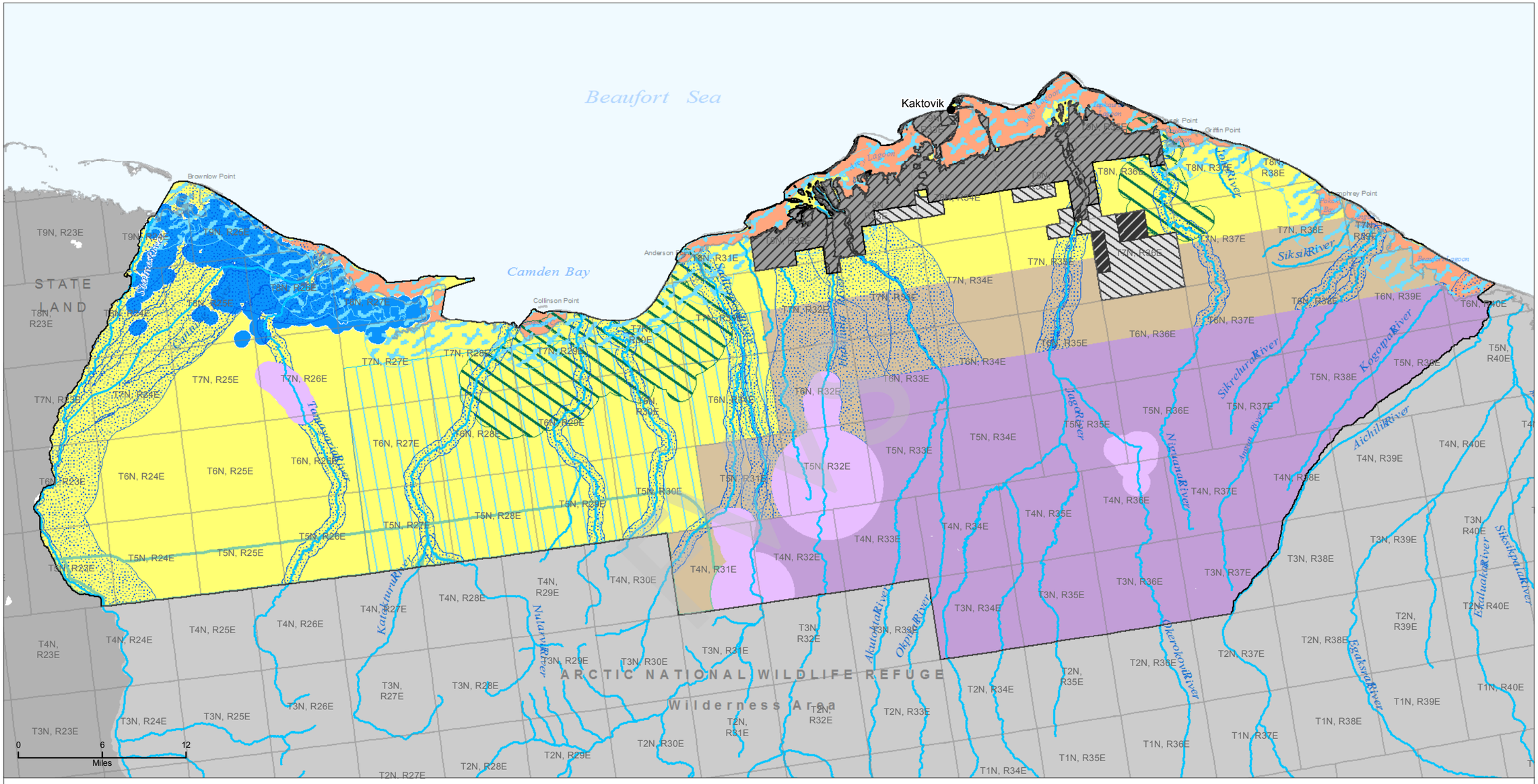
Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-7



Not offered for lease sale and not available for surface occupancy

- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 3—springs/aufeis

Available for lease sale, subject to no surface occupancy

- Lease stipulation 1—rivers and streams
- Lease stipulation 2—Canning River delta and lakes
- Lease stipulation 5—coastal polar bear river denning habitat
- Lease stipulation 9—coastal area
- Lease stipulation 7—porcupine caribou calving habitat
- Lease stipulation 10—Wilderness boundary

Available for lease sale, subject to controlled surface use

- Lease stipulation 8—porcupine caribou post-calving habitat

Available for lease sale, subject to timing limitations

- Lease stipulation 4—nearshore marine, lagoon, and barrier island habitat, exploration

Available for lease sale, subject to timing limitations

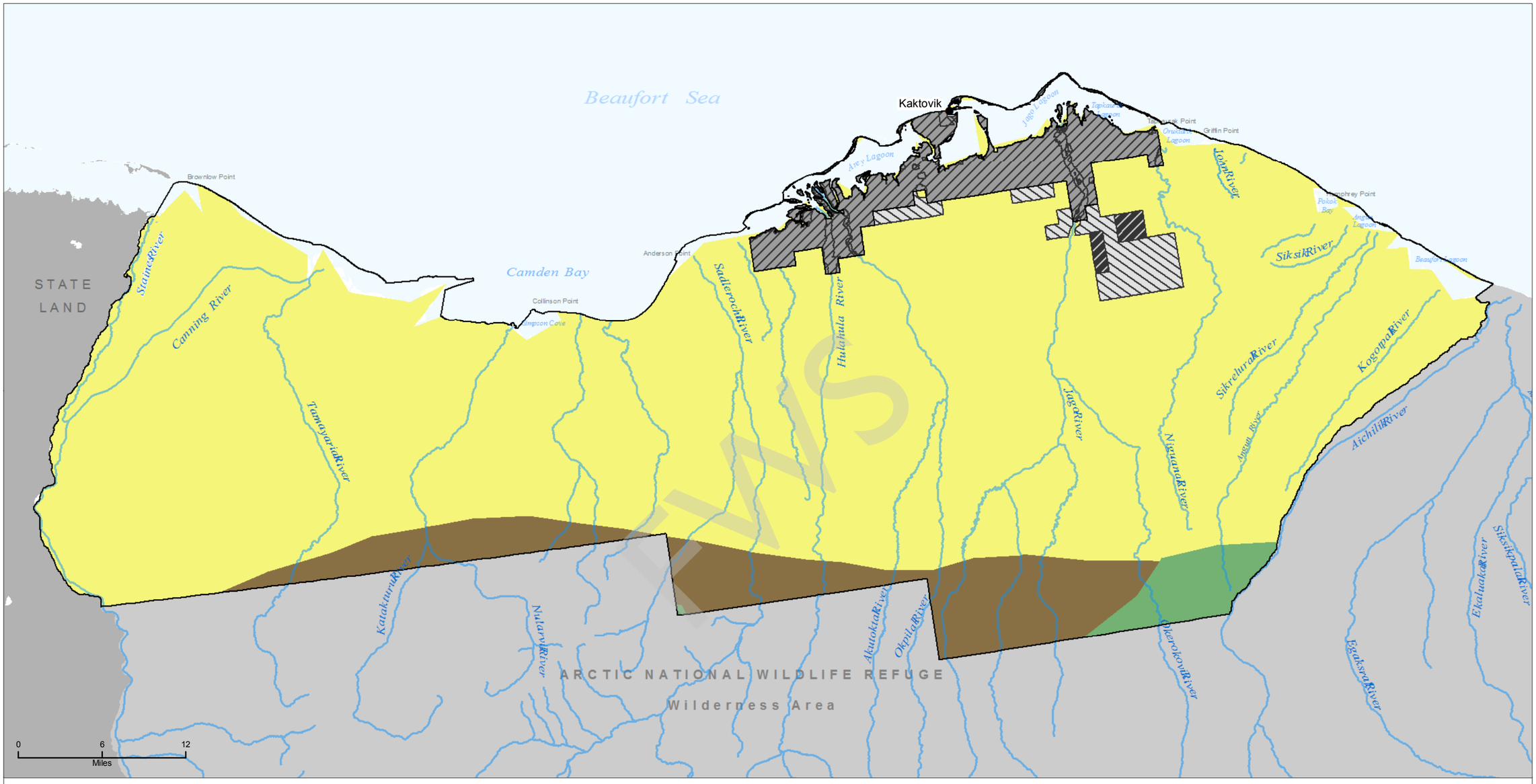
- Lease stipulation 6—Central Arctic and Porcupine Herds summer habitat
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 2-8



- Arctic Coastal Plain
- Arctic foothills
- Arctic mountains
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, Wahrhaftig GIS 1965
Print Date: 08/08/2018

Map 3-1

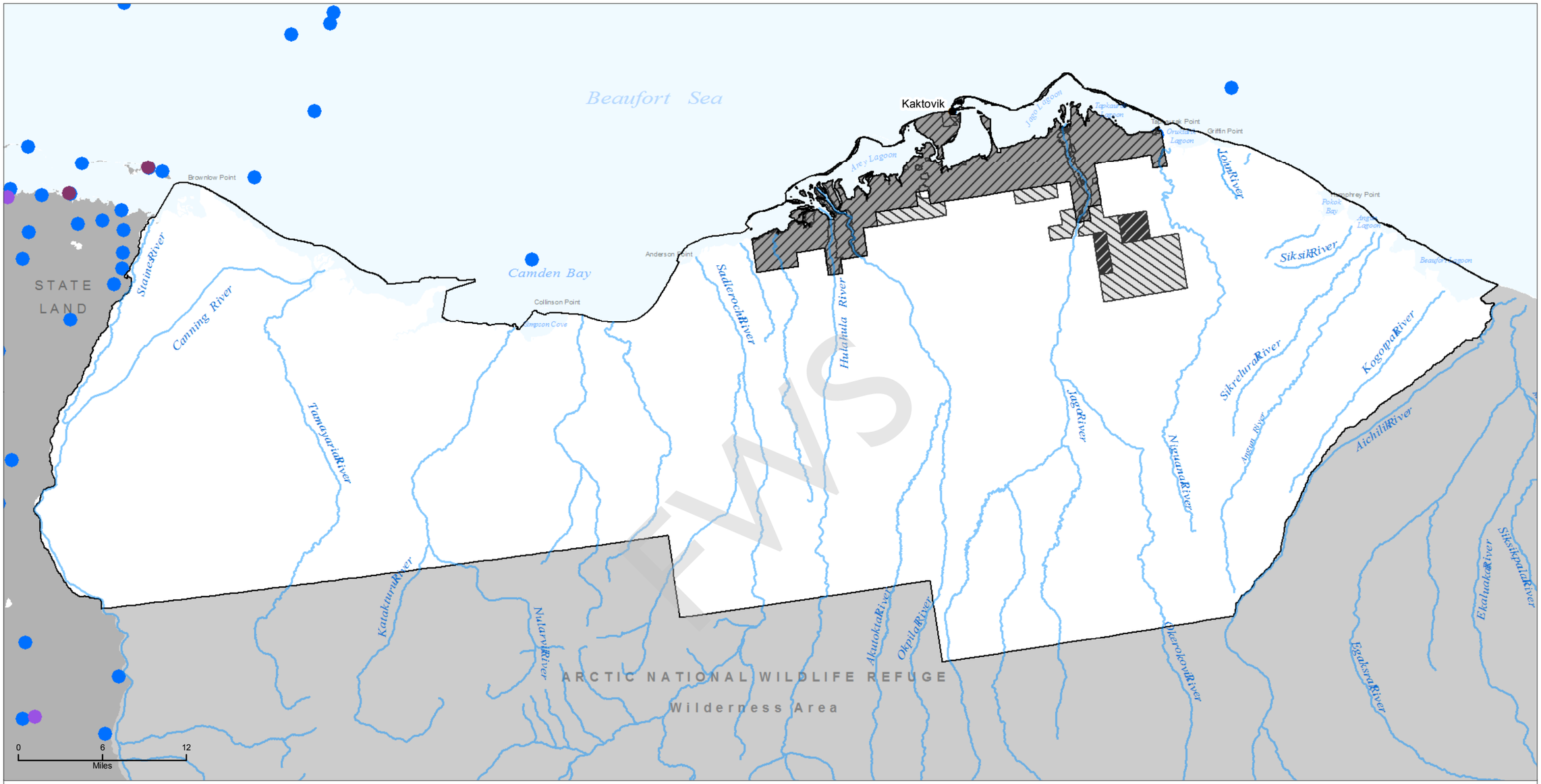
Beaufort Sea
Kaktovik
Brownlow Point
Anderson Point
Camden Bay
Collinson Point
Lagoon Cove
Griffin Point
Humphrey Point
Beaufort Lagoon
STATE LAND
Staines River
Canning River
Tamayariak River
Sadlerochit River
Hulahula River
Jago River
Niguanak River
Sikrelurak River
Angun River
Siksik River
John River
Kogotpak River
Aichilik River
Katakturuk River
Niglarvik River
Akutoktak River
Okpilak River
Okerokovik River
Egaksrak River
Ekaluakat River
Siksikpuk River
Itkilyariak Creek
Unnamed
Aichilik River
Unnamed
Katakturuk River
Fire Creek
Hulahula River
ARCTIC NATIONAL WILDLIFE REFUGE
Wilderness Area
0 6 12
Miles

▲ Mines, prospects, and mineral occurrences

Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

Data Source: BLM GIS 2018, ARDF GIS 2018
Print Date: 08/08/2018

Map 3-2



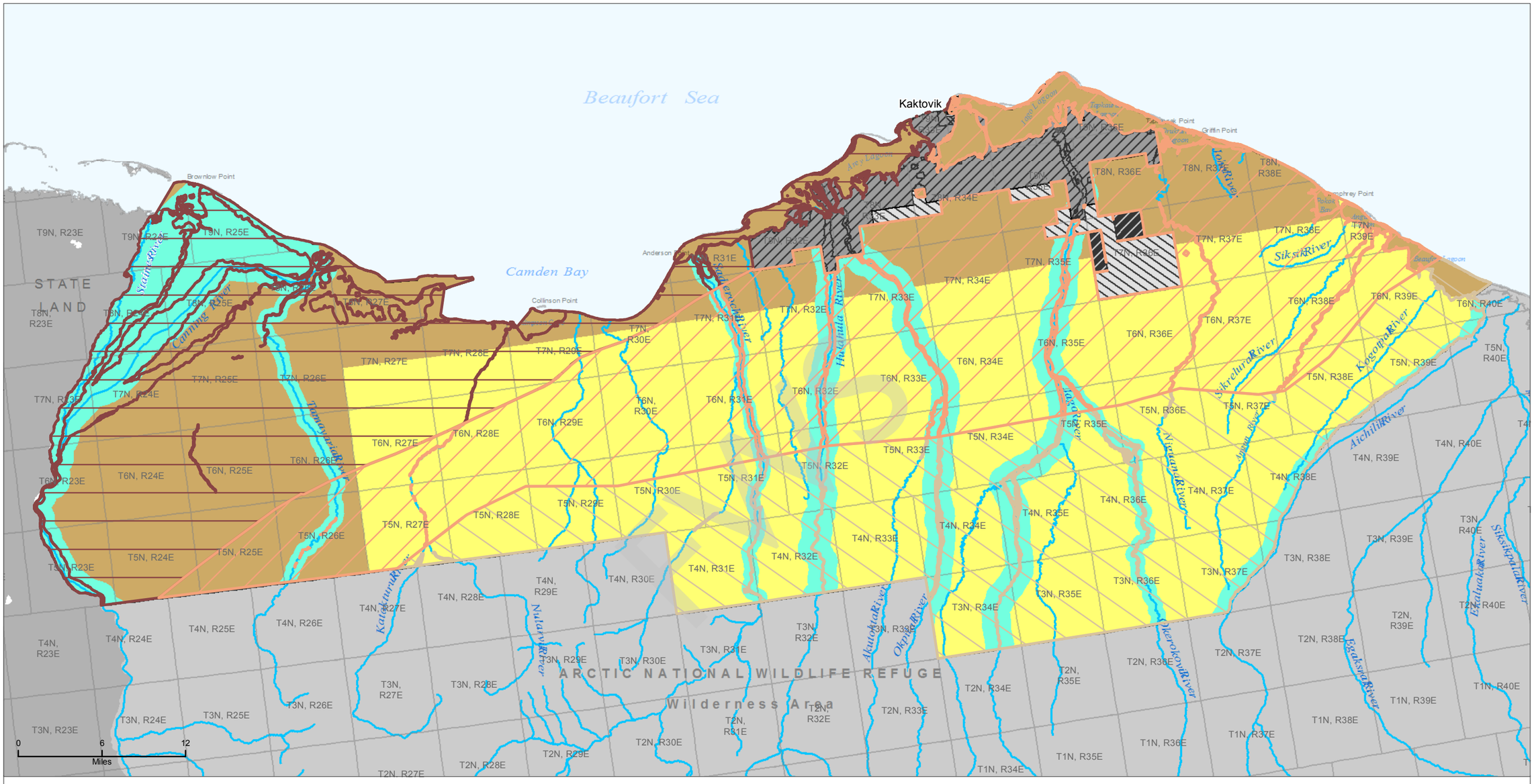
Wellheads
- Development
- Service
- Exploratory
- Stratigraphic test
- Unclassified

- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, AOGCC GIS 2018
Print Date: 08/08/2018

Map 3-3



Not offered for lease sale (none)

Available for lease sale:

- Subject to no surface occupancy
- Subject to controlled surface use (none)
- Subject to timing limitations
- Subject to standard terms and conditions

Hydrocarbon potential

- High
- Medium
- Low

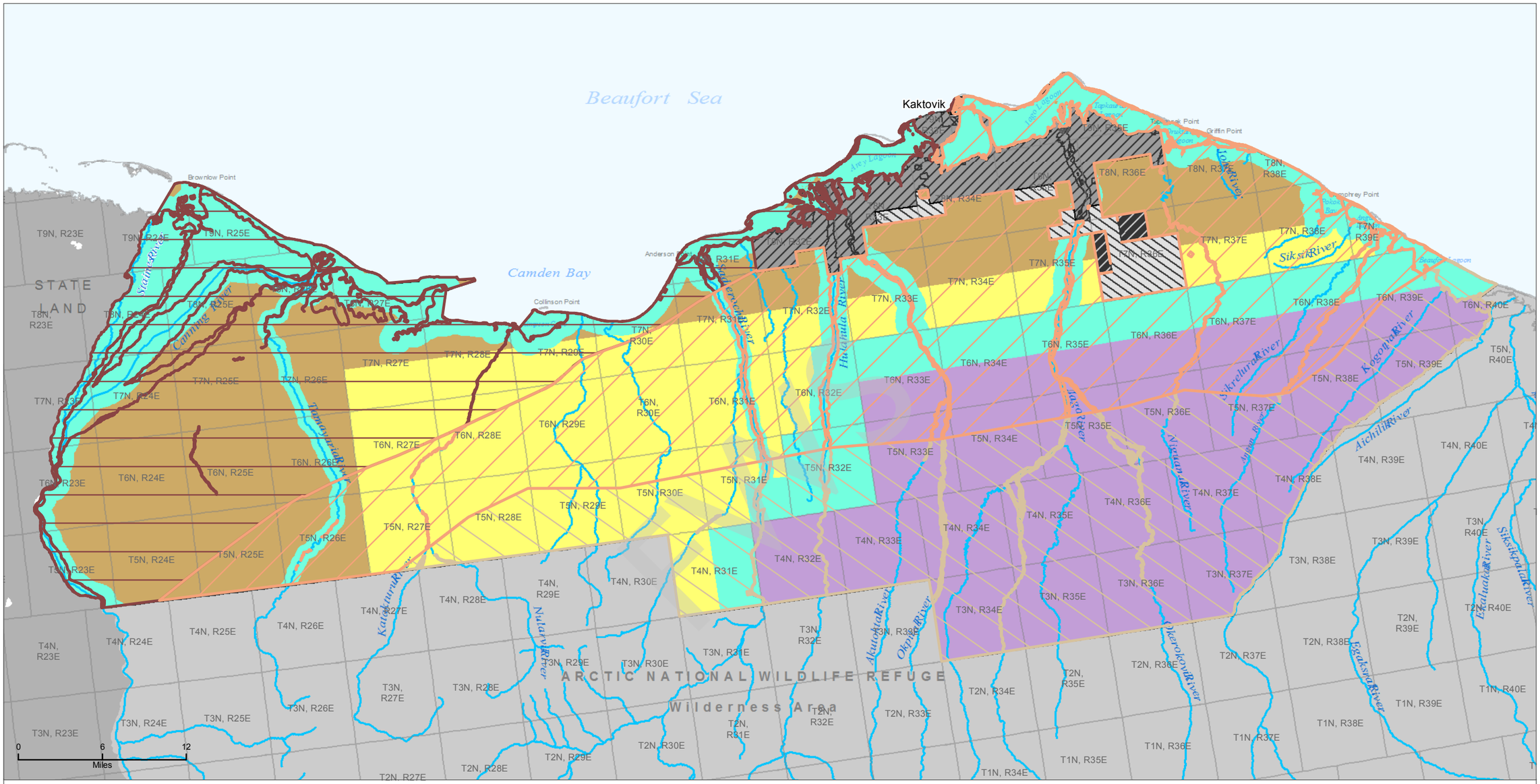
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 3-4



Not offered for lease sale

Available for lease sale:
- Subject to no surface occupancy
- Subject to controlled surface use (none)
- Subject to timing limitations
- Subject to standard terms and conditions

Hydrocarbon potential
- High
- Medium
- Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
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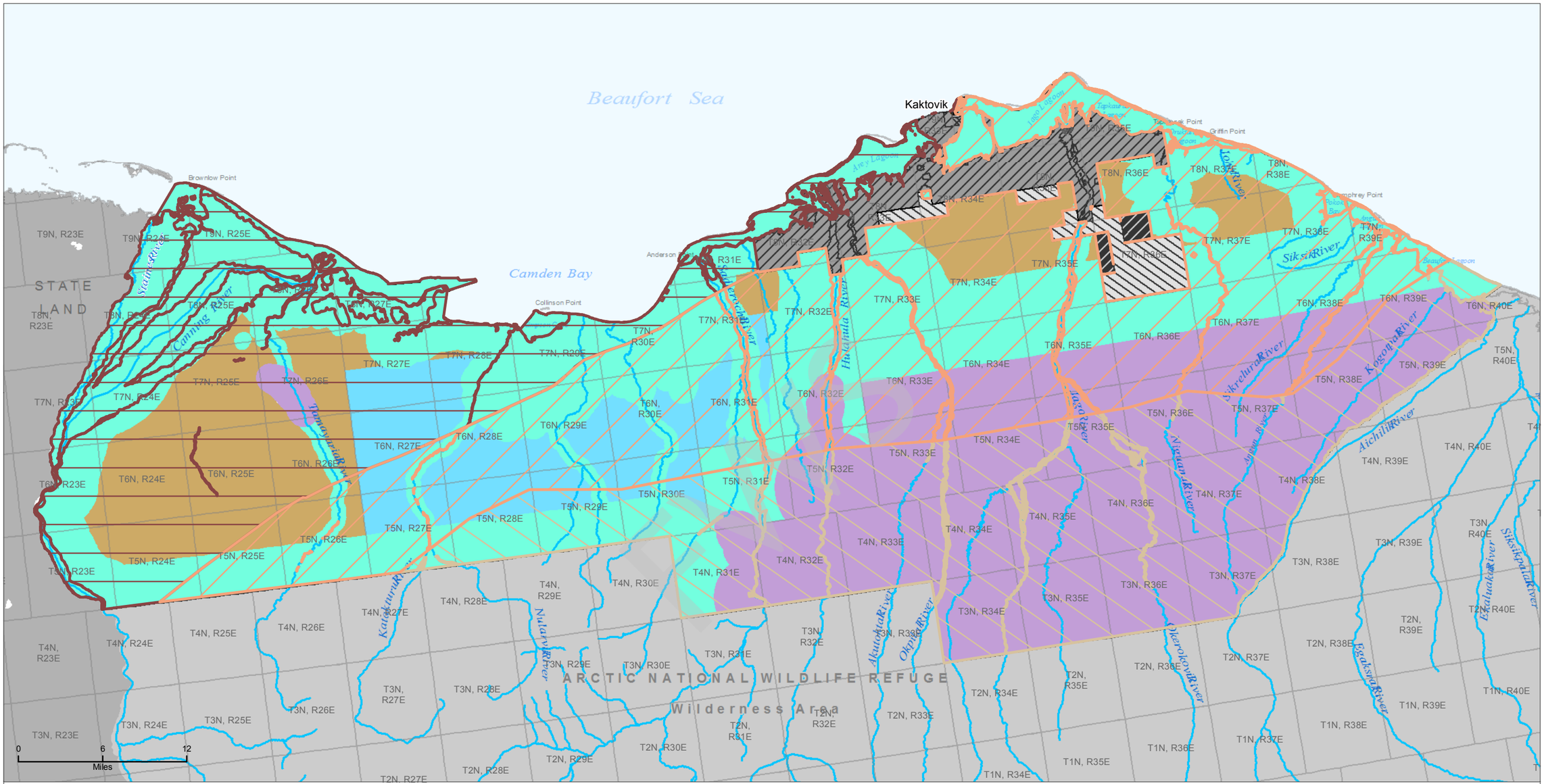
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 3-5



Not offered for lease sale

Available for lease sale:
- Subject to no surface occupancy
- Subject to controlled surface use
- Subject to timing limitations (none)
- Subject to standard terms and conditions

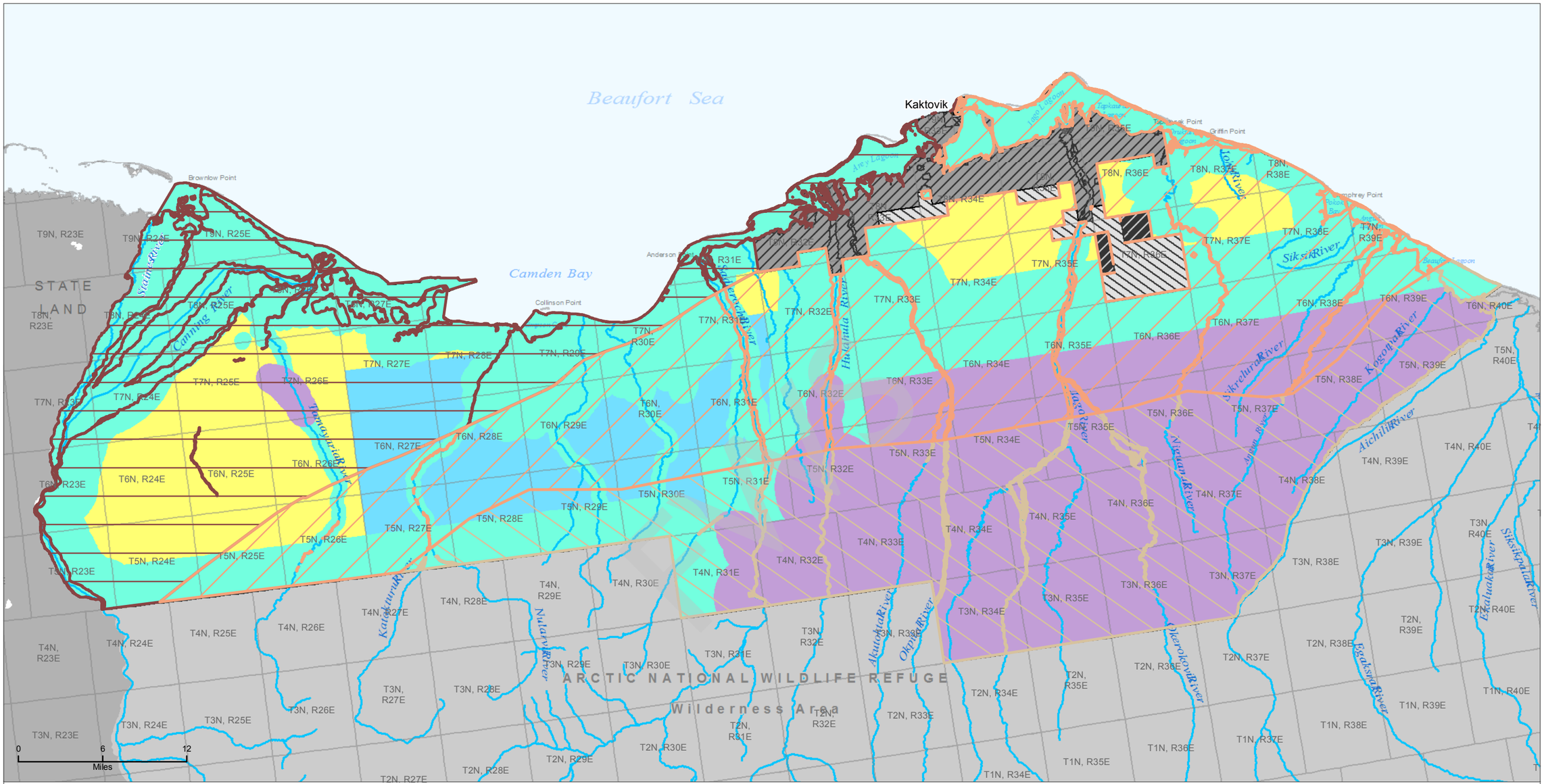
Hydrocarbon potential
- High
- Medium
- Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 3-6



Not offered for lease sale

Available for lease sale:
- Subject to no surface occupancy
- Subject to controlled surface use
- Subject to timing limitations
- Subject to standard terms and conditions (none)

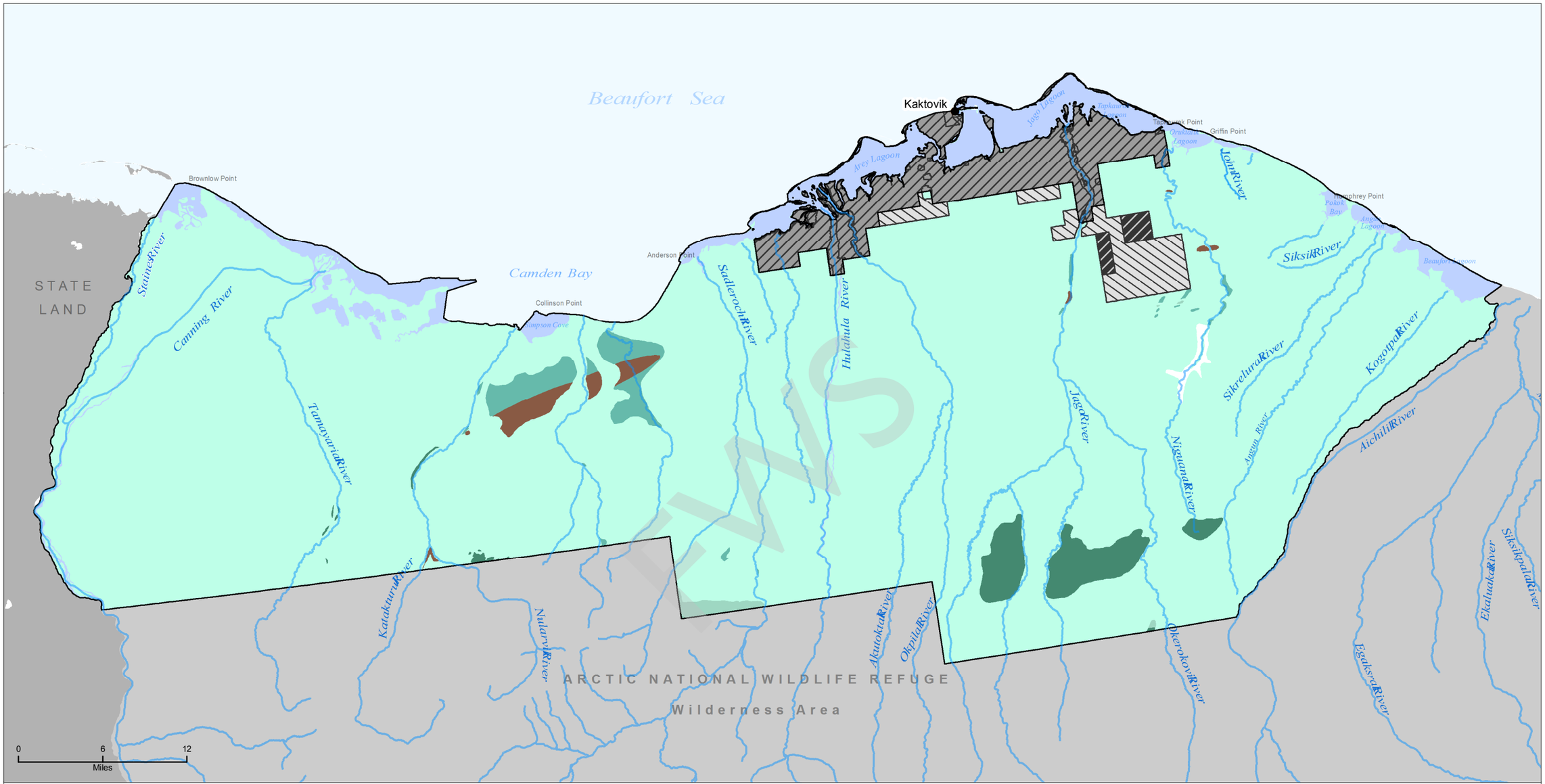
Hydrocarbon potential
- High
- Medium
- Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, FWS GIS 2018
Print Date: 08/08/2018

Map 3-7



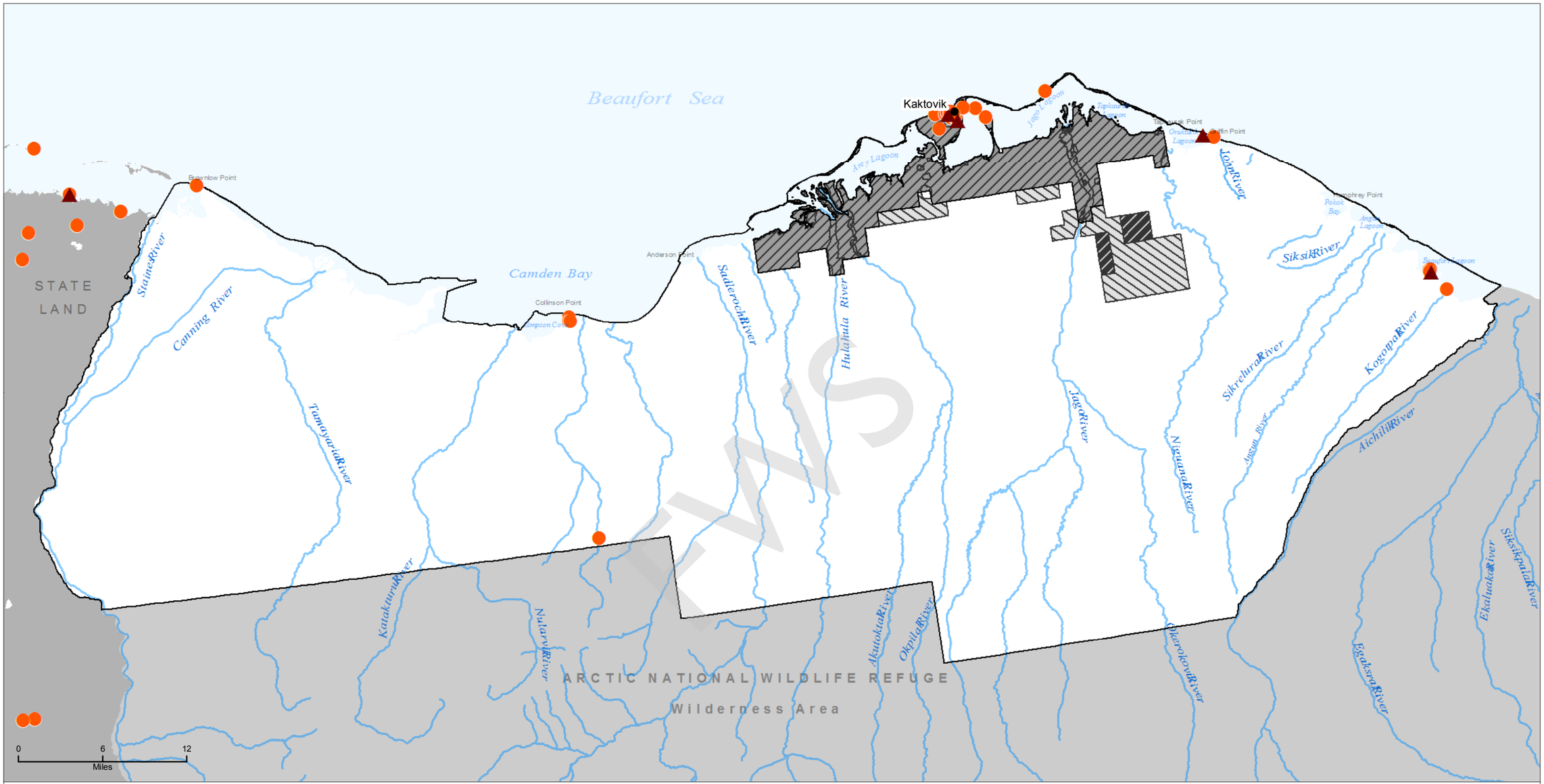
Potential fossil yield classification
- 2-3
- 3
- 3-4
- 5
- Unknown
- Water

- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, USGS GIS 2015
Print Date: 08/08/2018

Map 3-8



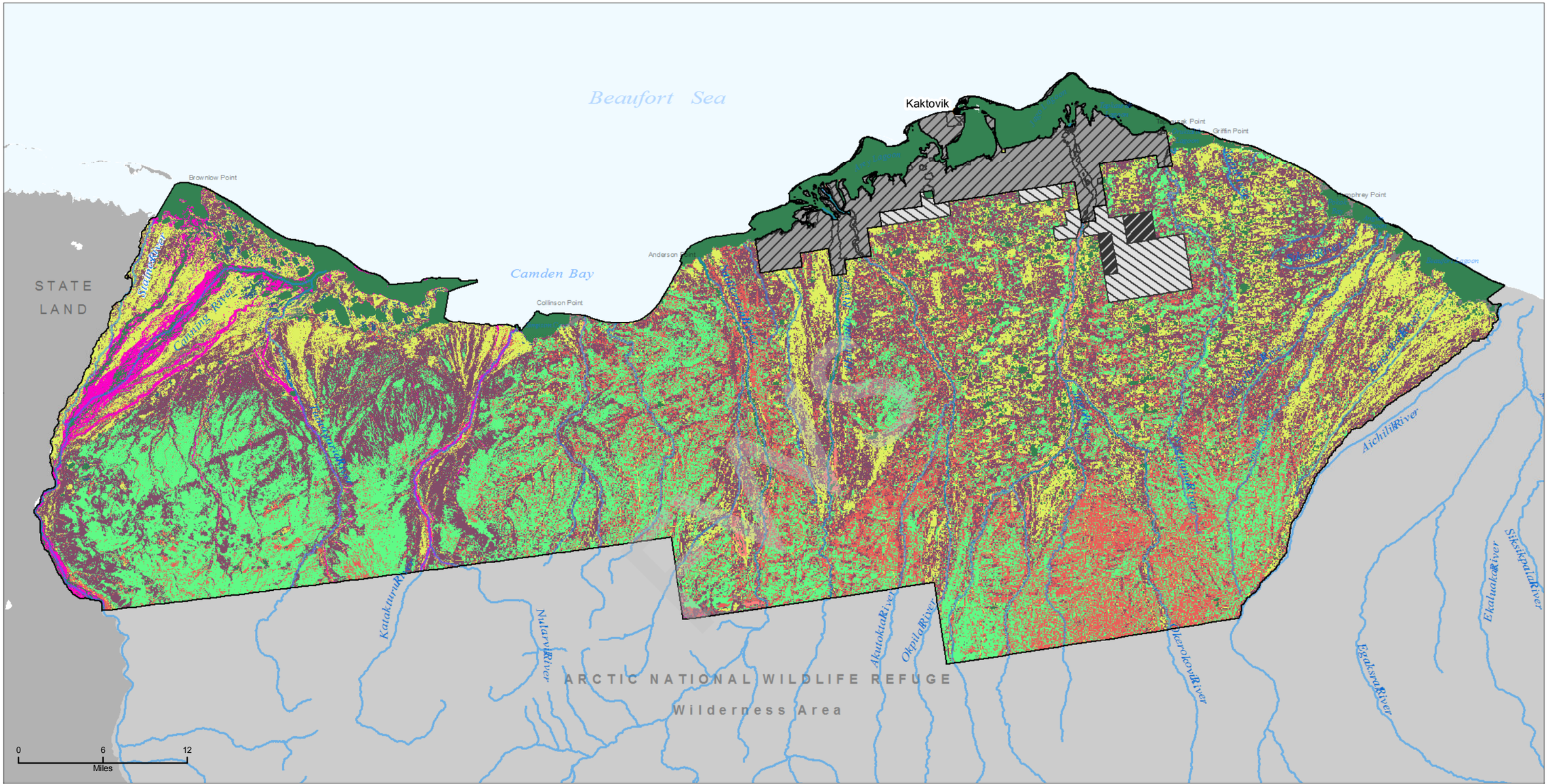
- Alaska Department of Environmental Conservation—contaminated site
- Resource Conservation and Recovery Act site
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

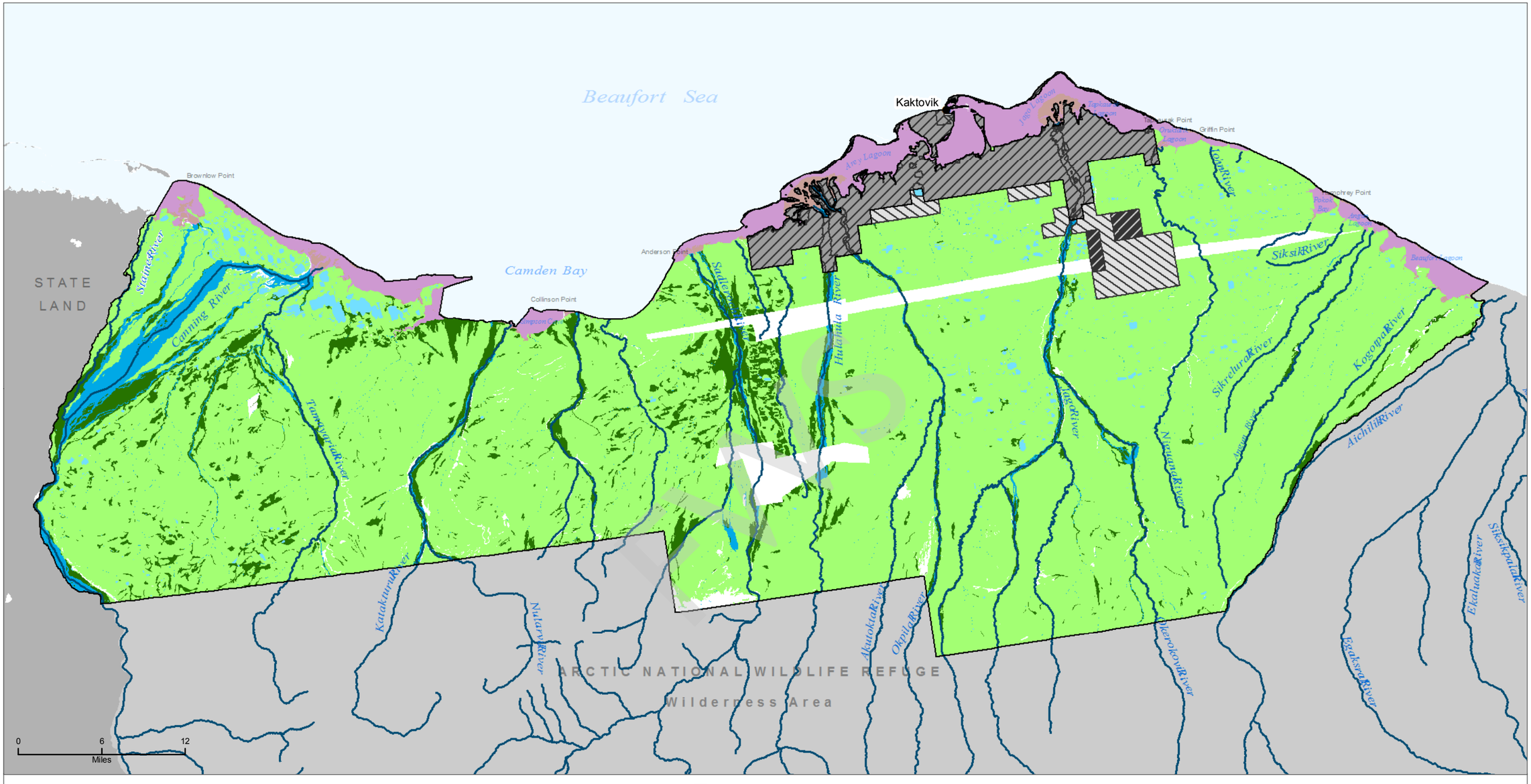
Data Source: BLM GIS 2018, ADEC GIS 2018, EPA GIS 2018
Print Date: 08/08/2018

Map 3-9



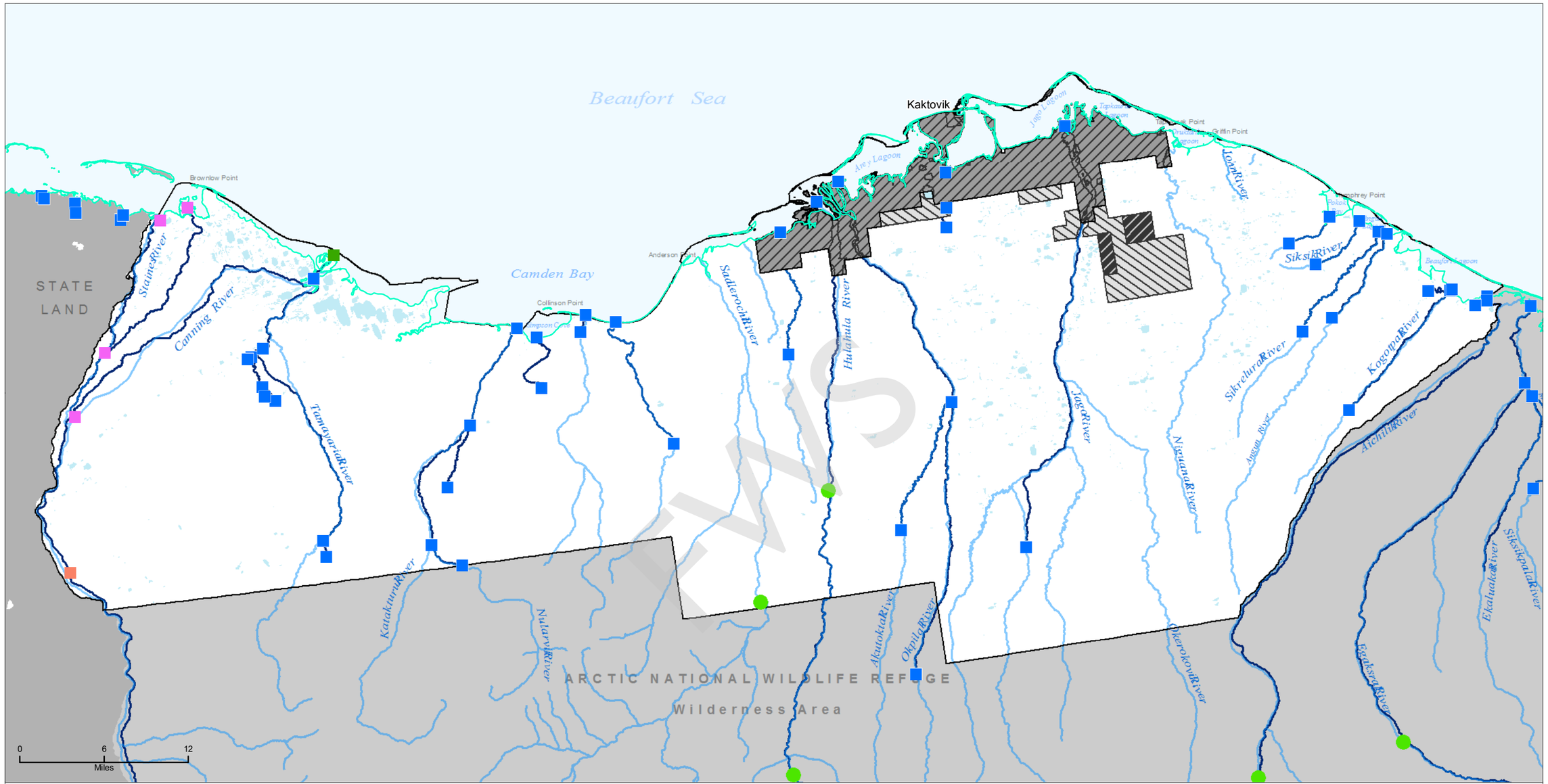
Data Source: BLM GIS 2018, ACCS GIS 2018
Print Date: 08/08/2018

Map 3-10



Data Source: BLM GIS 2018, NWI GIS 2018
Print Date: 08/08/2018

Map 3-11



Anadromous water catalog (AWC) Fish Presence
- Dolly Varden
- Pink Salmon, Dolly Varden and Whitefish
- Chum Salmon, Pink Salmon, Dolly Varden and Whitefish
- Pink Salmon and Whitefish

- AWC stream
- Dolly Varden spawning or overwintering site
- Coastline
- Lake

- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
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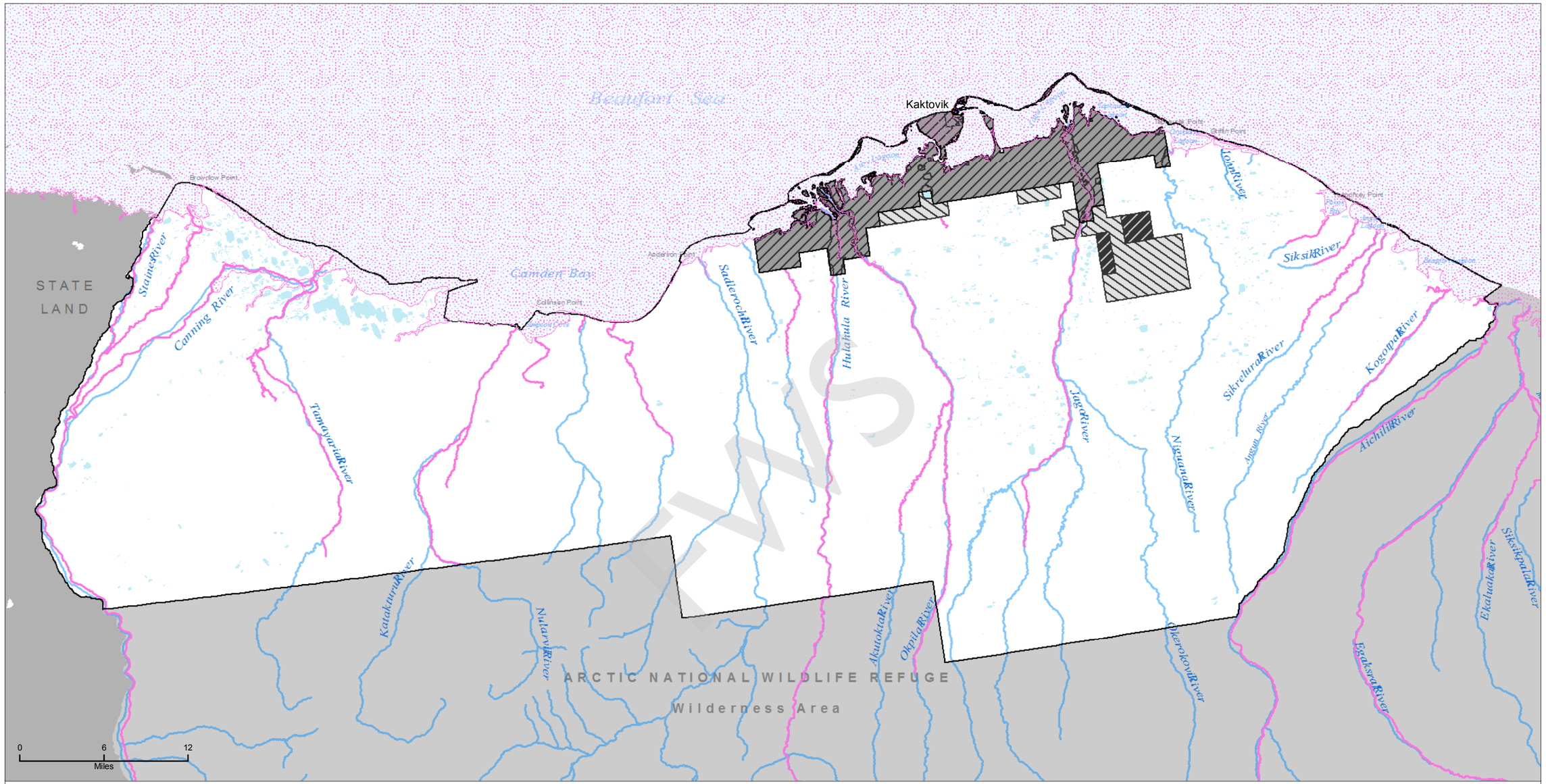
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, ADFG GIS 2018
Print Date: 08/08/2018

Map 3-12



Essential fish habitat

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

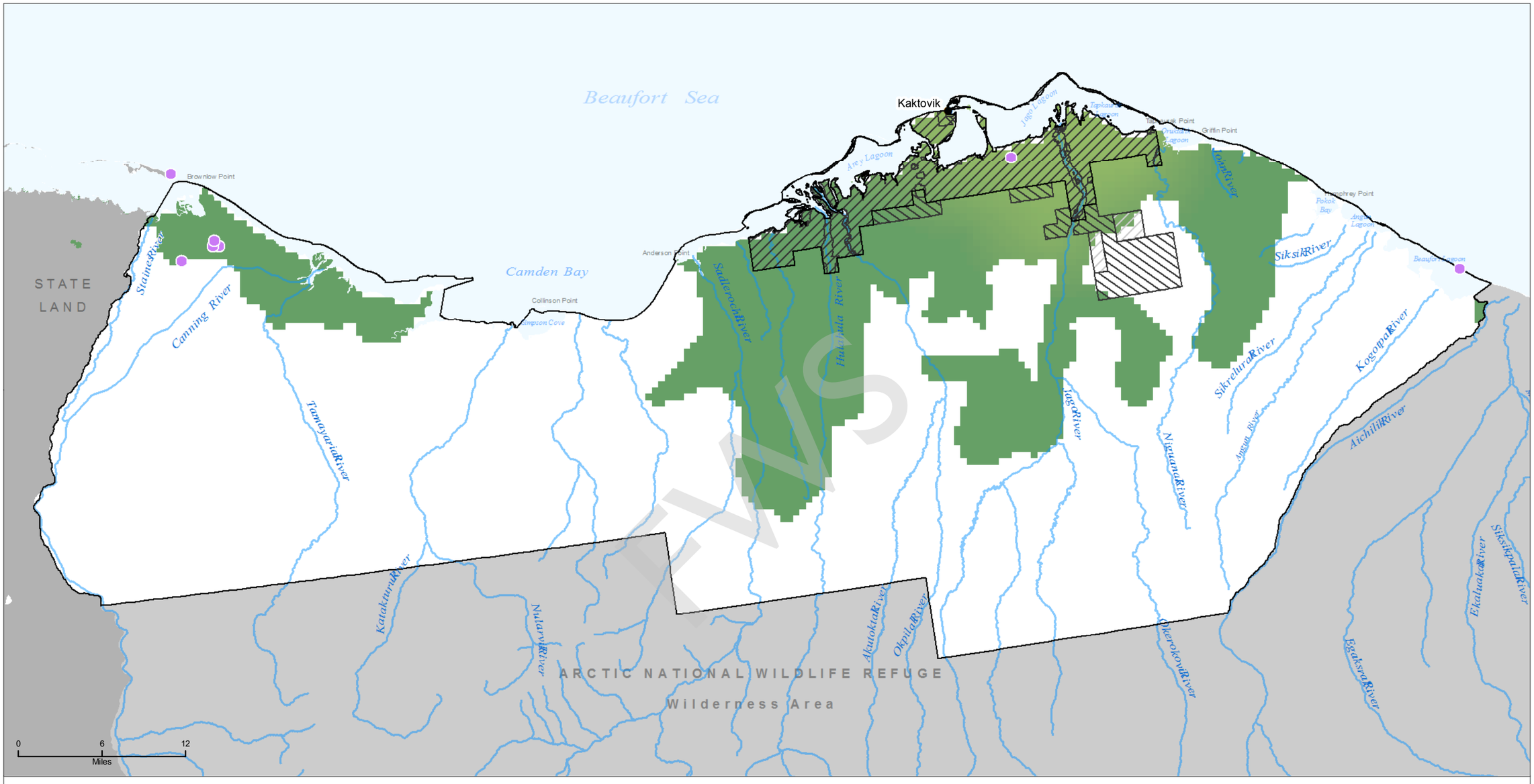
Excluded from Public Law 115-97 Coastal Plain

Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, NOAA GIS 2018, ADFG GIS 2018

Map 3-13



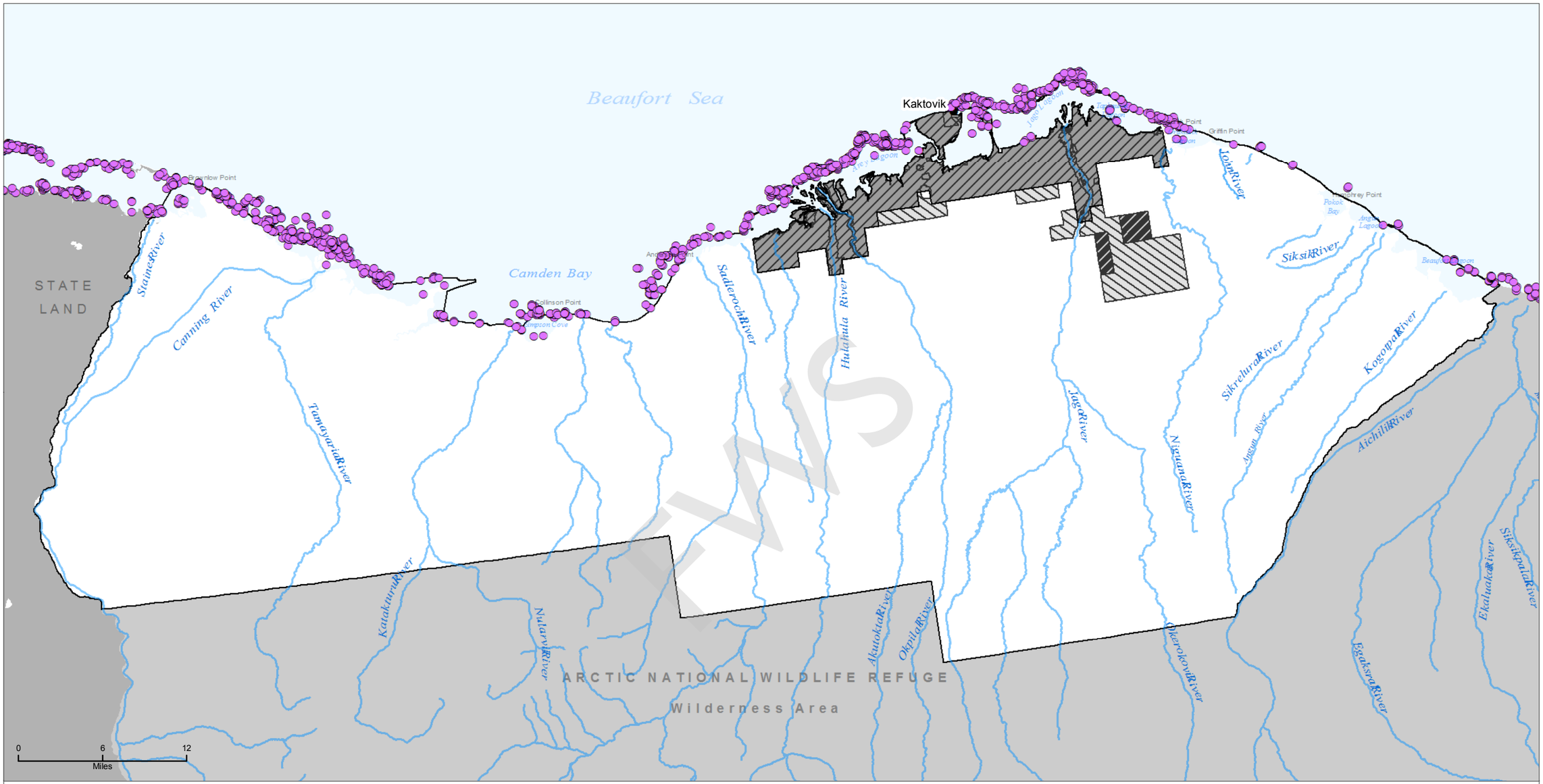
All spectacled eider observations from the North Slope Eider aerial survey, 1992-2006, and the Arctic Coastal Plain breeding waterbird aerial survey, 1992-2014, aerial survey sightings 1999-2007

Interpolated density (birds/km2) of spectacled eiders from bird observations collected during the ACP aerial breeding pair waterbird survey, 2012-2015.
- High density
- Low density

Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, USFWS ACP GIS 2007
Print Date: 08/08/2018

Map 3-14



Common eider sightings during 1999–2007 surveys

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

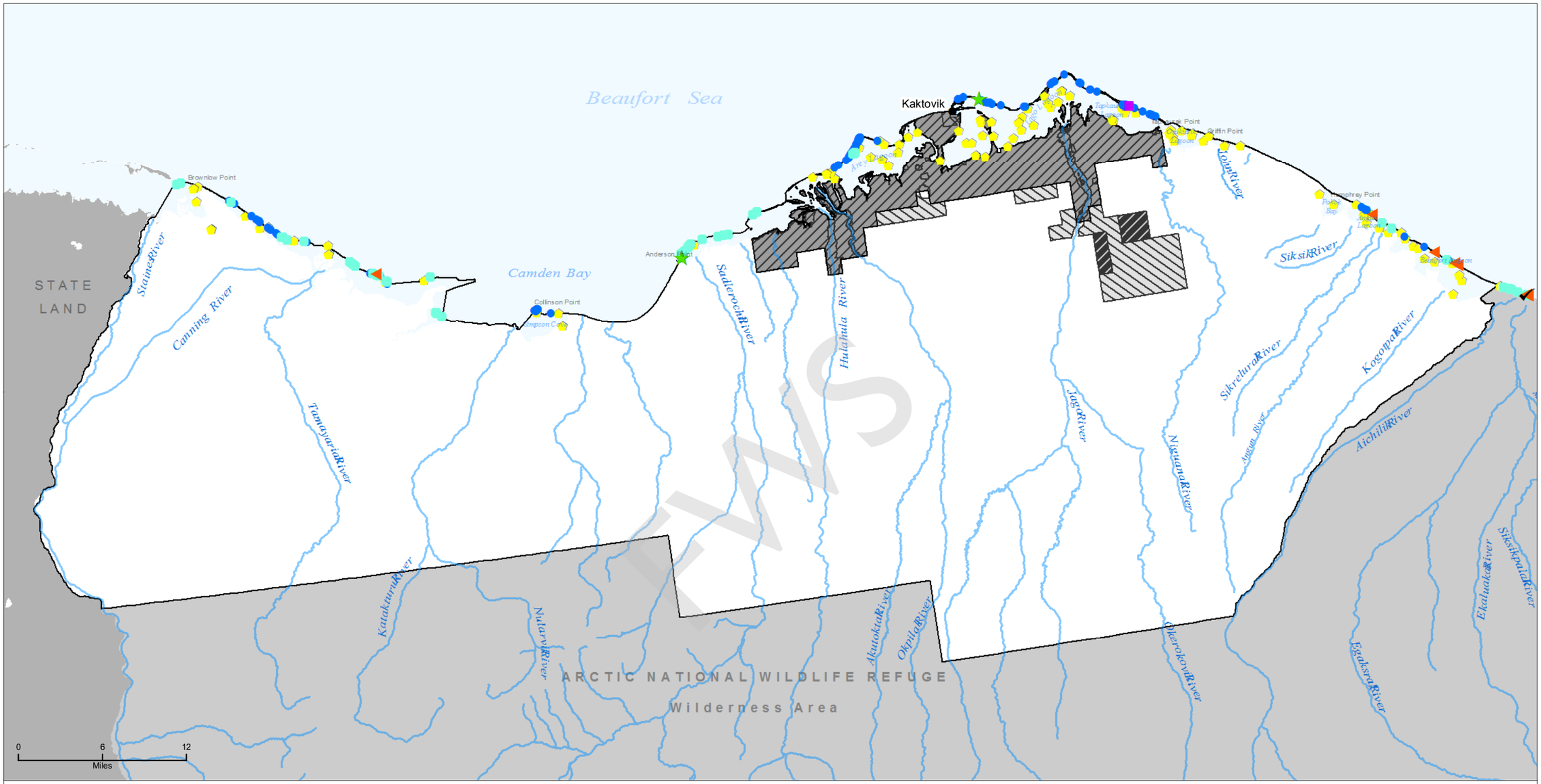
Excluded from Public Law 115-97 Coastal Plain

Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, USFWS ACP GIS 2007
Print Date: 08/08/2018

Map 3-15



- Common eider
- Arctic tern
- Black Guillemot
- Glaucous gull
- Long-tailed duck
- Snow bunting

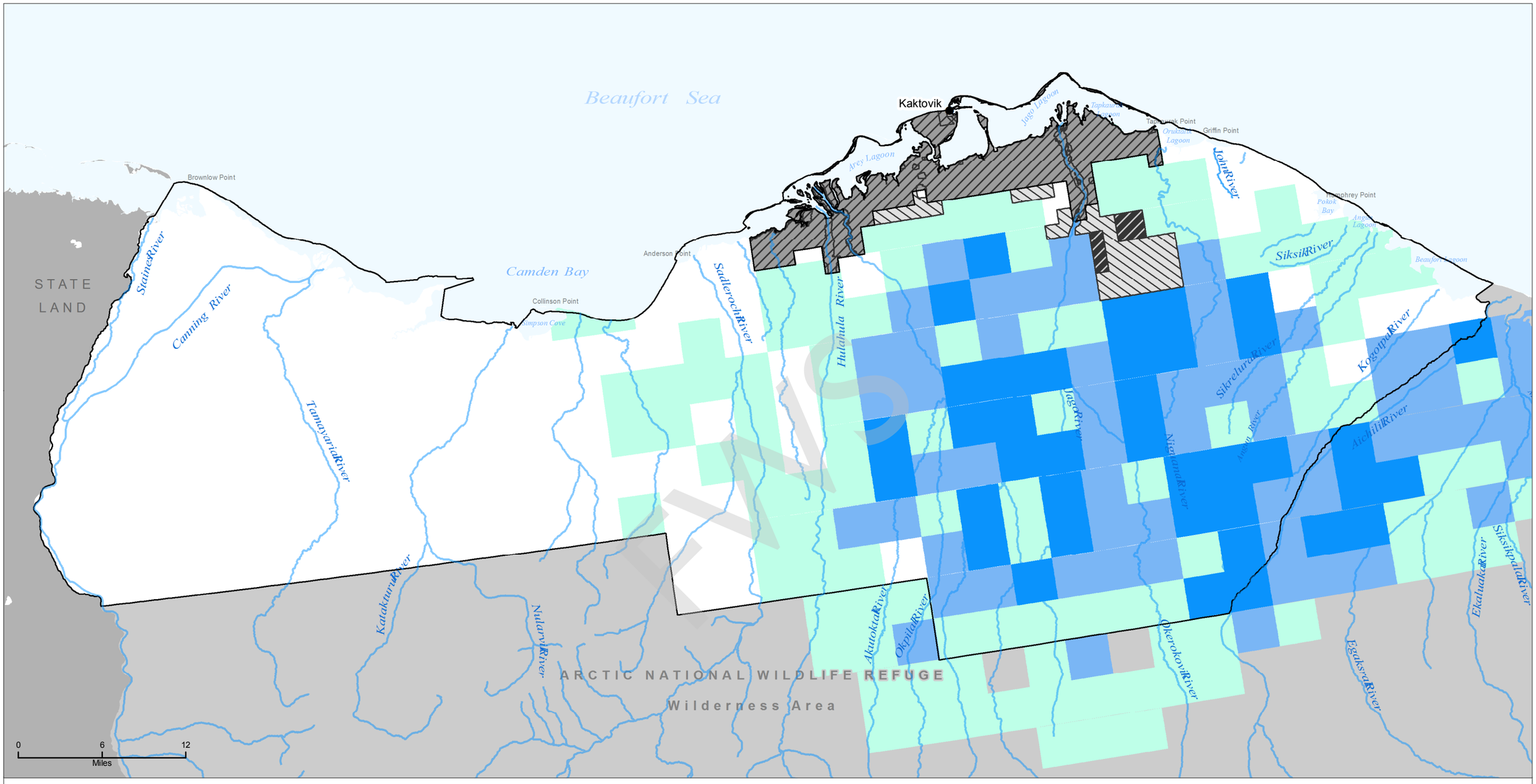
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, USFWS ACP GIS 2007
Print Date: 08/08/2018

Map 3-16



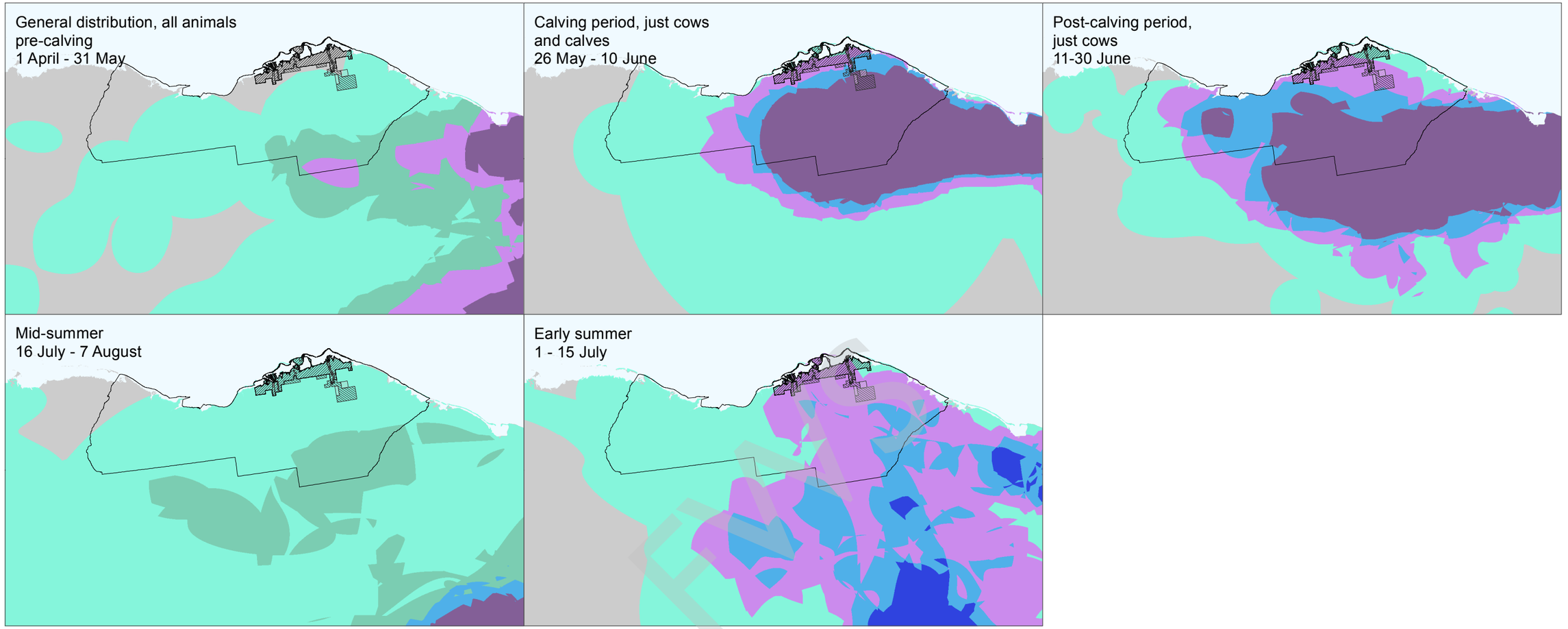
- High density snow geese
- Medium density snow geese
- Low density snow geese
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, USFWS ACP GIS 2007
Print Date: 08/08/2018

Map 3-17



Percent of years that caribou are present

- < 20%
- 20 - 30%
- 30 - 40%
- > 40%

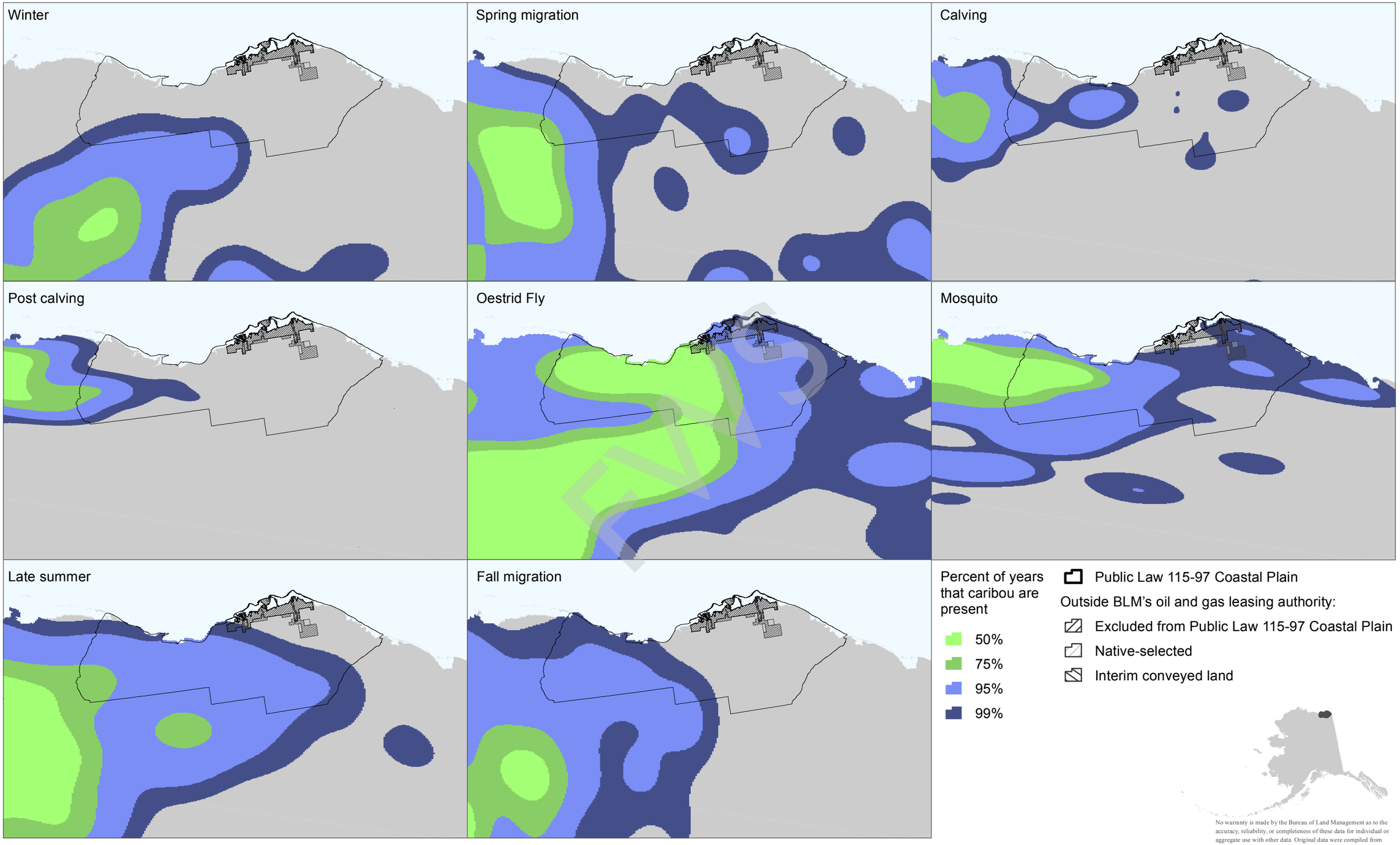
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

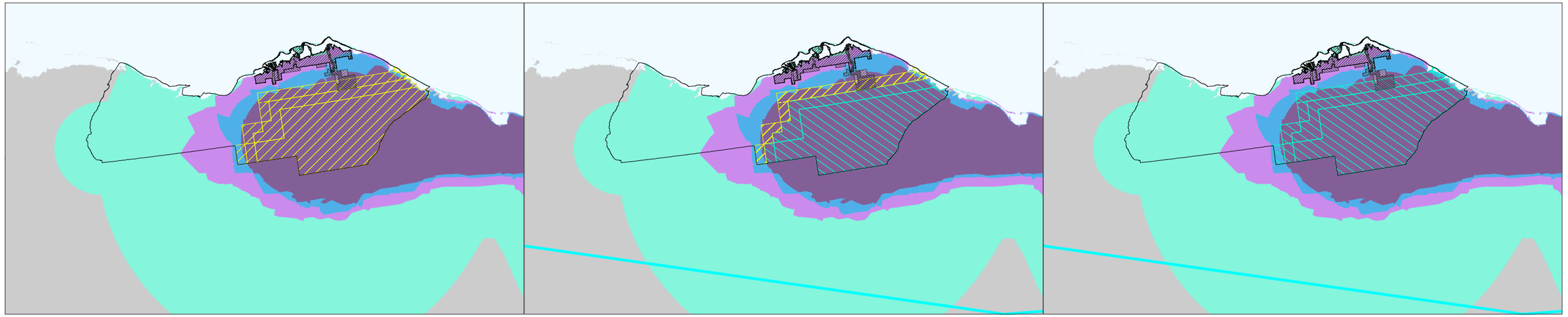
Data Source: BLM GIS 2018,
Yukon Environmental
GIS 2018
Print Date: 08/08/2018

Map 3-18



Data Source: BLM GIS 2018, ABR GIS 2017
Print Date: 08/08/2018

Map 3-19



Alternative B:

- Lease stipulation 7—porcupine caribou calving habitat, timing limitation

Percent of years that caribou are present

- < 20%
- 20 - 30%
- 30 - 40%
- > 40%
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Alternative C:

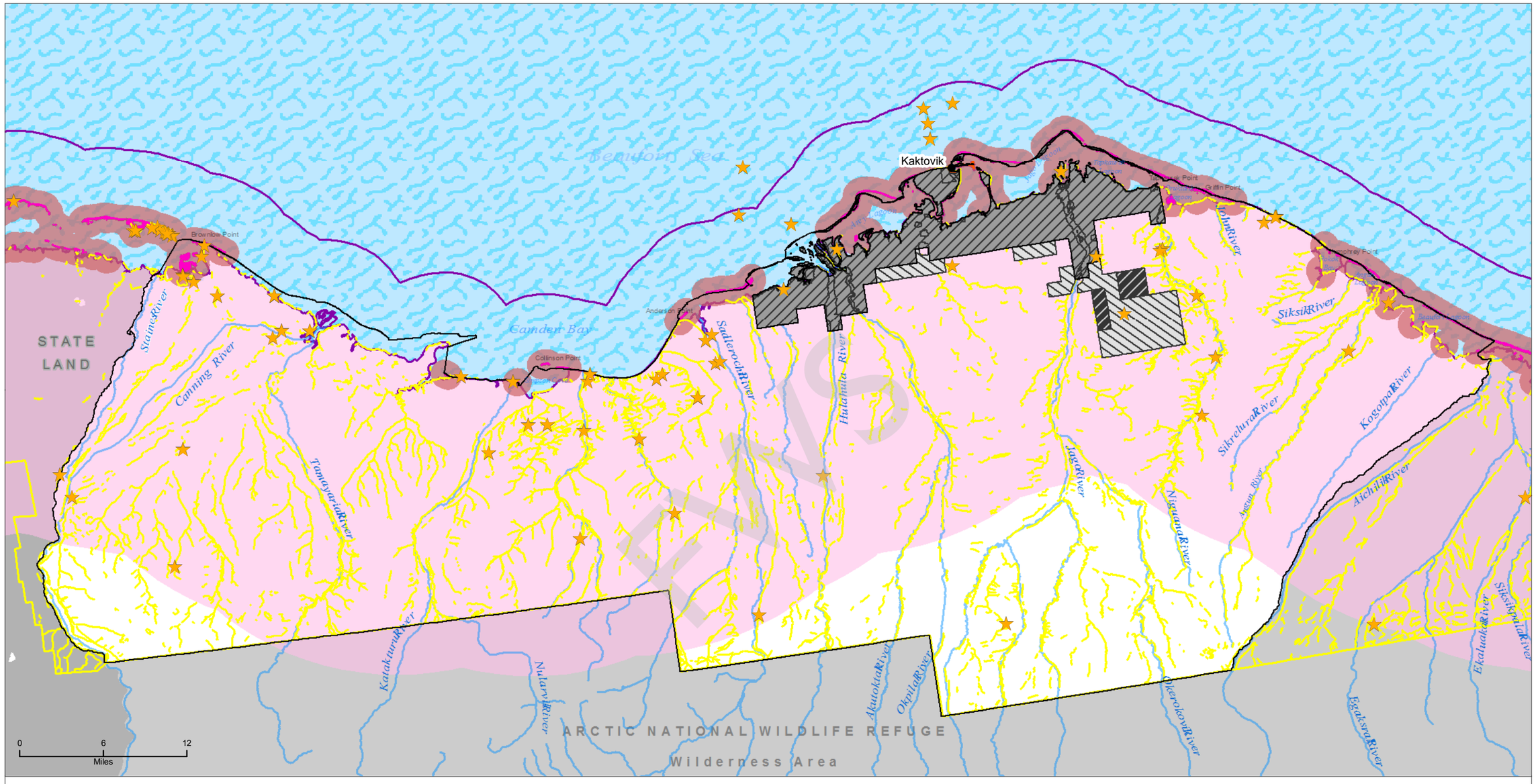
- Lease stipulation 7—porcupine caribou calving habitat, not offered for lease sale or no surface occupancy
- Lease stipulation 7—porcupine caribou calving habitat, timing limitation

Alternatives D1 and D2:

- Lease stipulation 7—porcupine caribou calving habitat, no surface occupancy

Data Source: BLM GIS 2018, Yukon Environmental GIS 2018
Print Date: 08/08/2018

Map 3-20



- Polar Bear dens (Durner data)
- Polar Bear habitat (Durner data)
- 5-mile coastal buffer

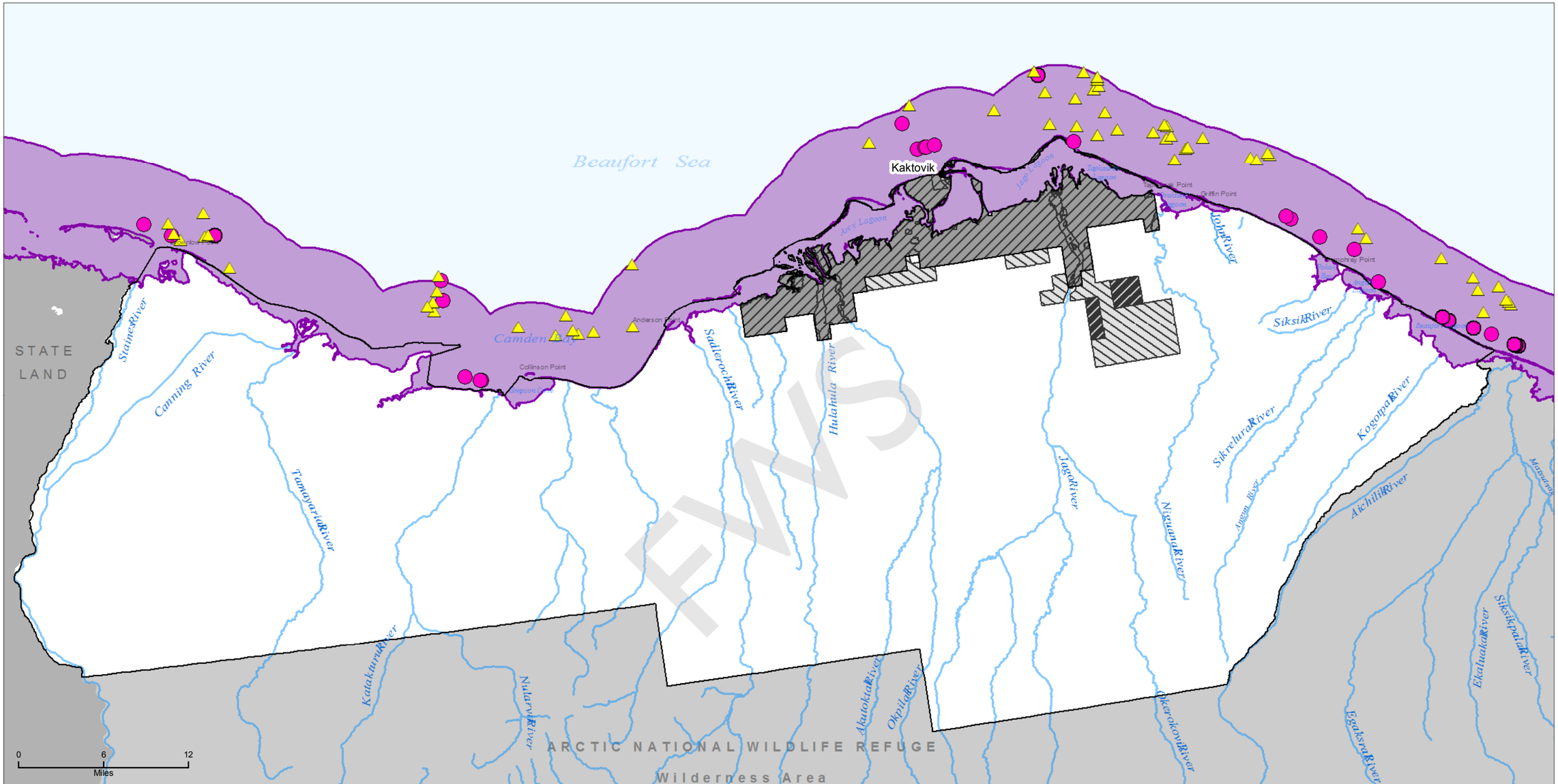
Polar bear critical habitat
- Barrier islands
- No disturbance zone
- Denning (95% den locations)
- Feeding

- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, USFWS GIS 2010, USGS GIS 2005
Print Date: 08/08/2018

Map 3-21



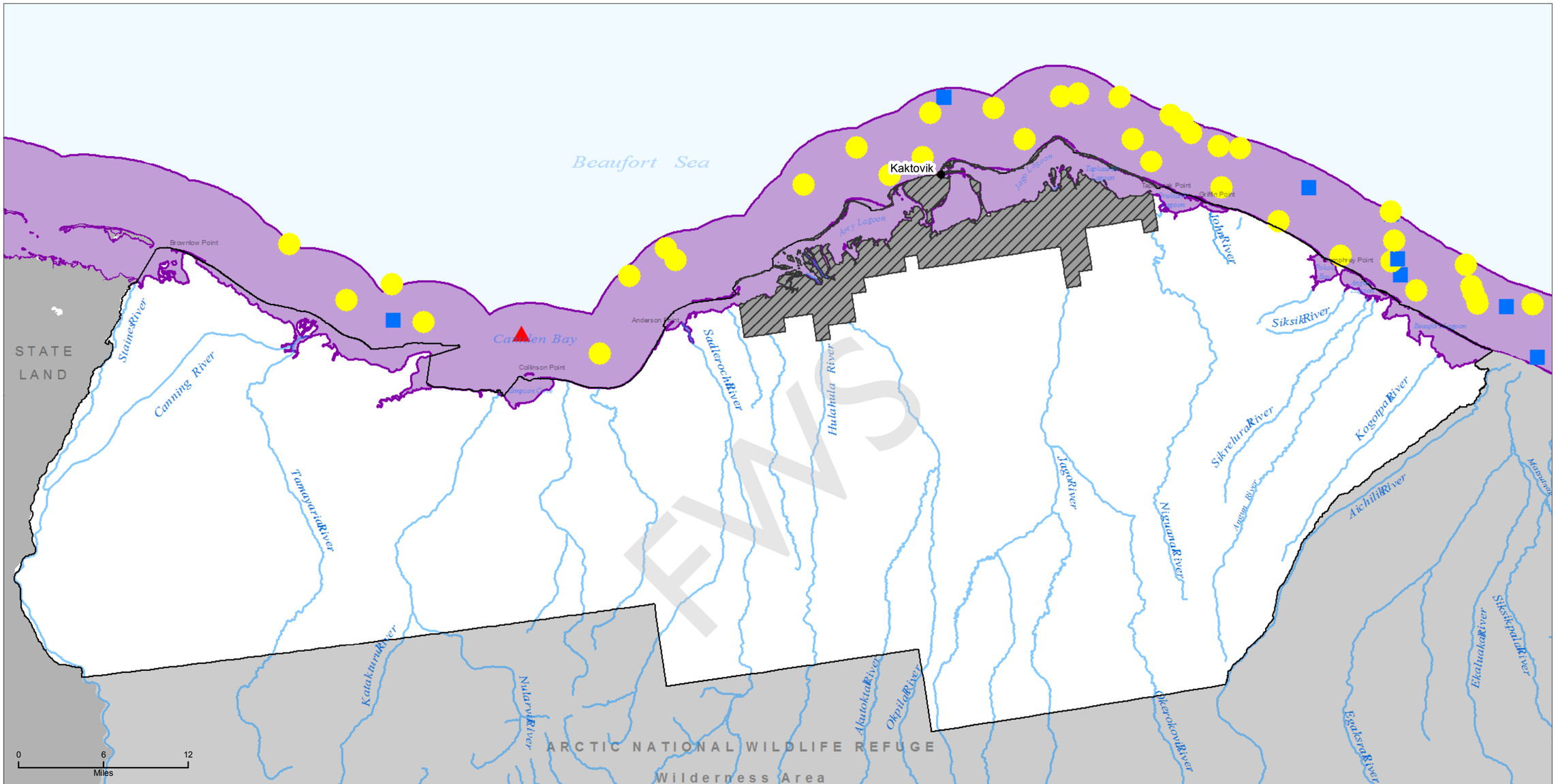
- Bowhead whale sighting (2012–2016)
- Beluga whale sighting (2012–2016)
- 5-mile coastal buffer
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

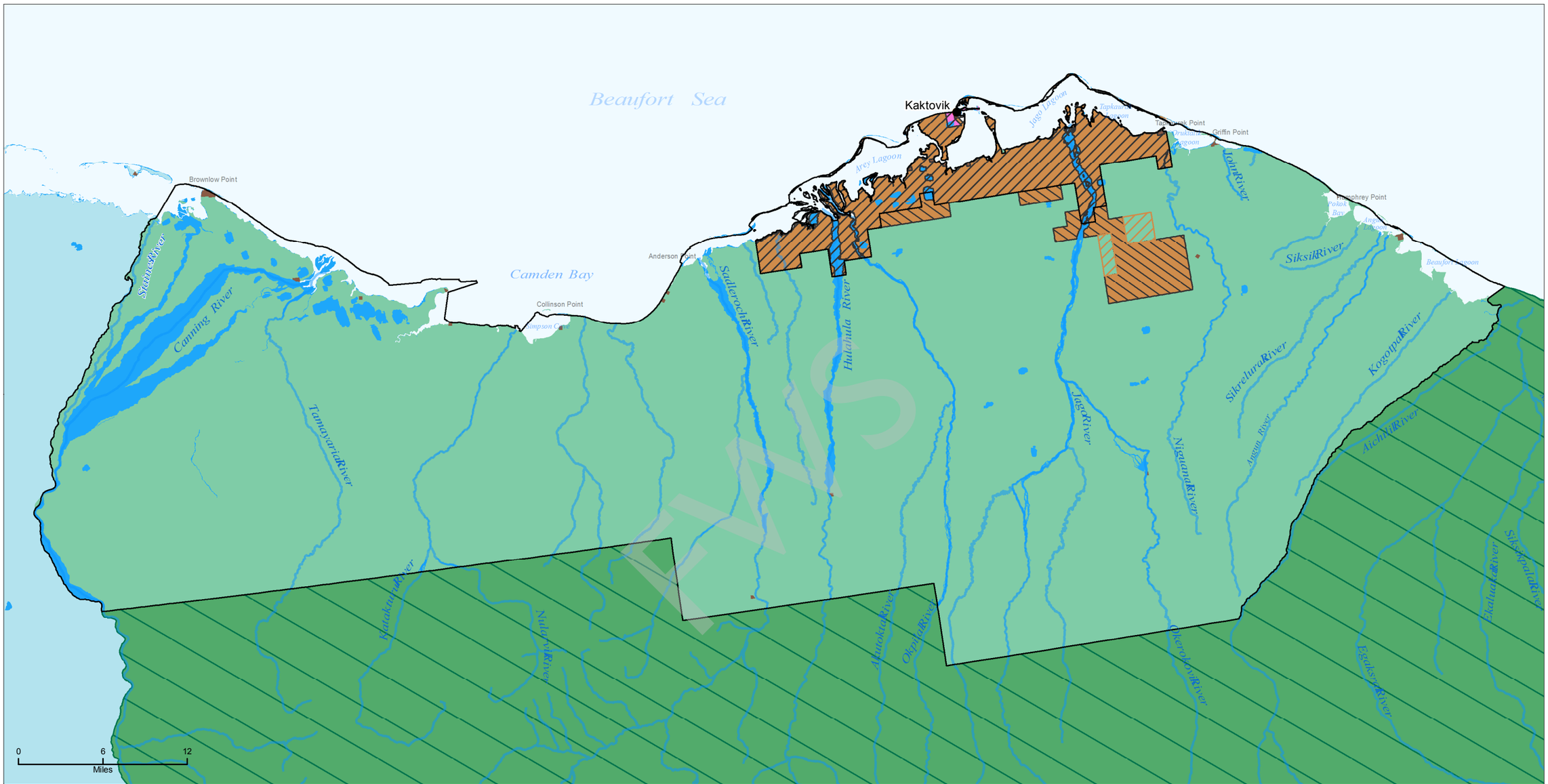
Data Source: BLM GIS 2018, ASAMM GIS 2016
Print Date: 08/08/2018

Map 3-22



Data Source: BLM GIS 2018, ASAMM GIS 2016
Print Date: 08/08/2018

Map 3-23



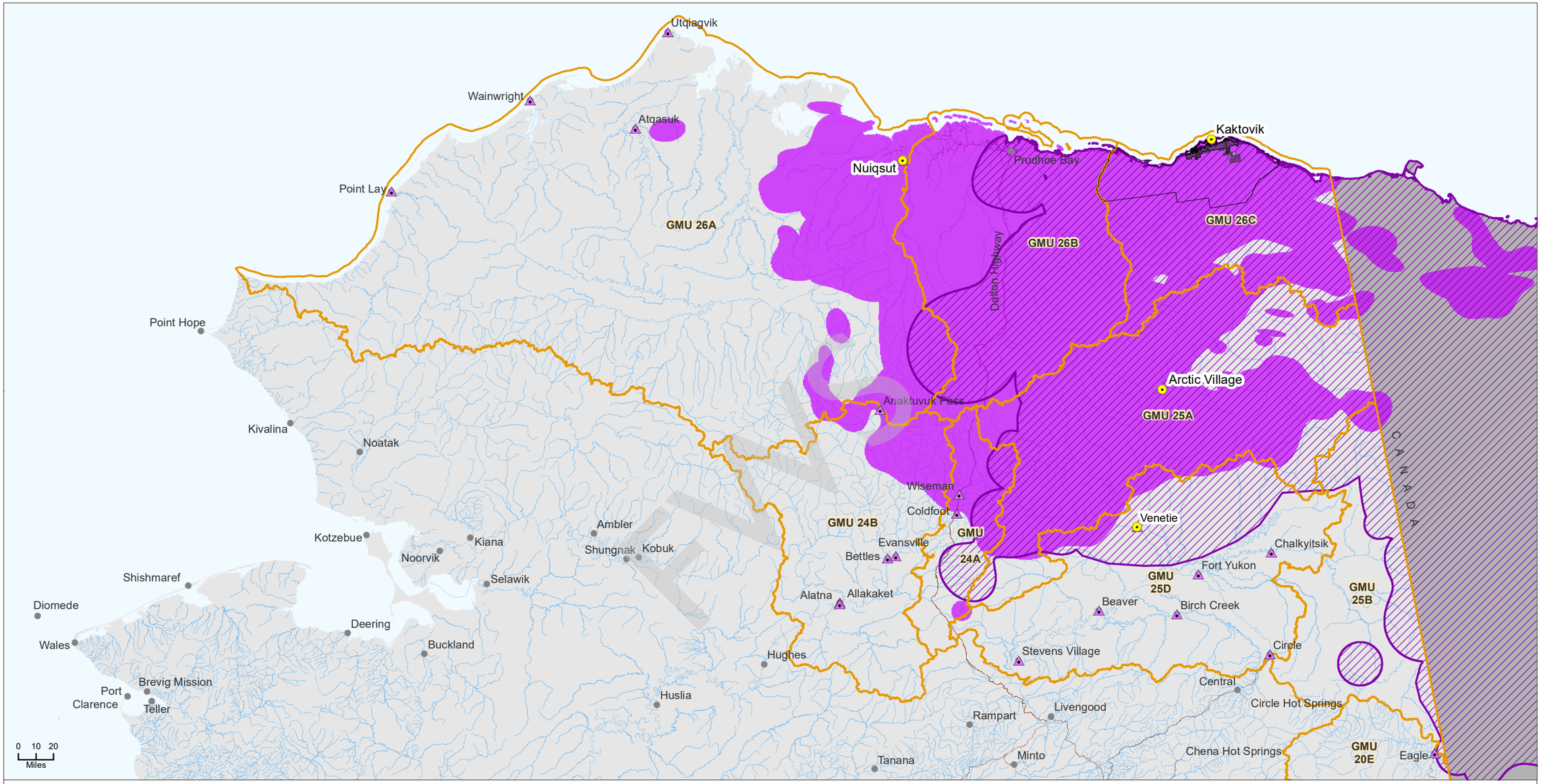
- U.S. Fish and Wildlife Service
- U.S. Fish and Wildlife Service, wilderness area
- Native lands (patented or interim conveyed)
- State
- Air Force
- Native allotment
- Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018
Print Date: 08/08/2018

Map 3-24



- Subsistence study community
- Caribou study community
- Other community
- Game management unit (Alaska Department of Fish and Game)
- Central Arctic Herd range
- Porcupine Herd range
- Public Law 115-97 Coastal Plain

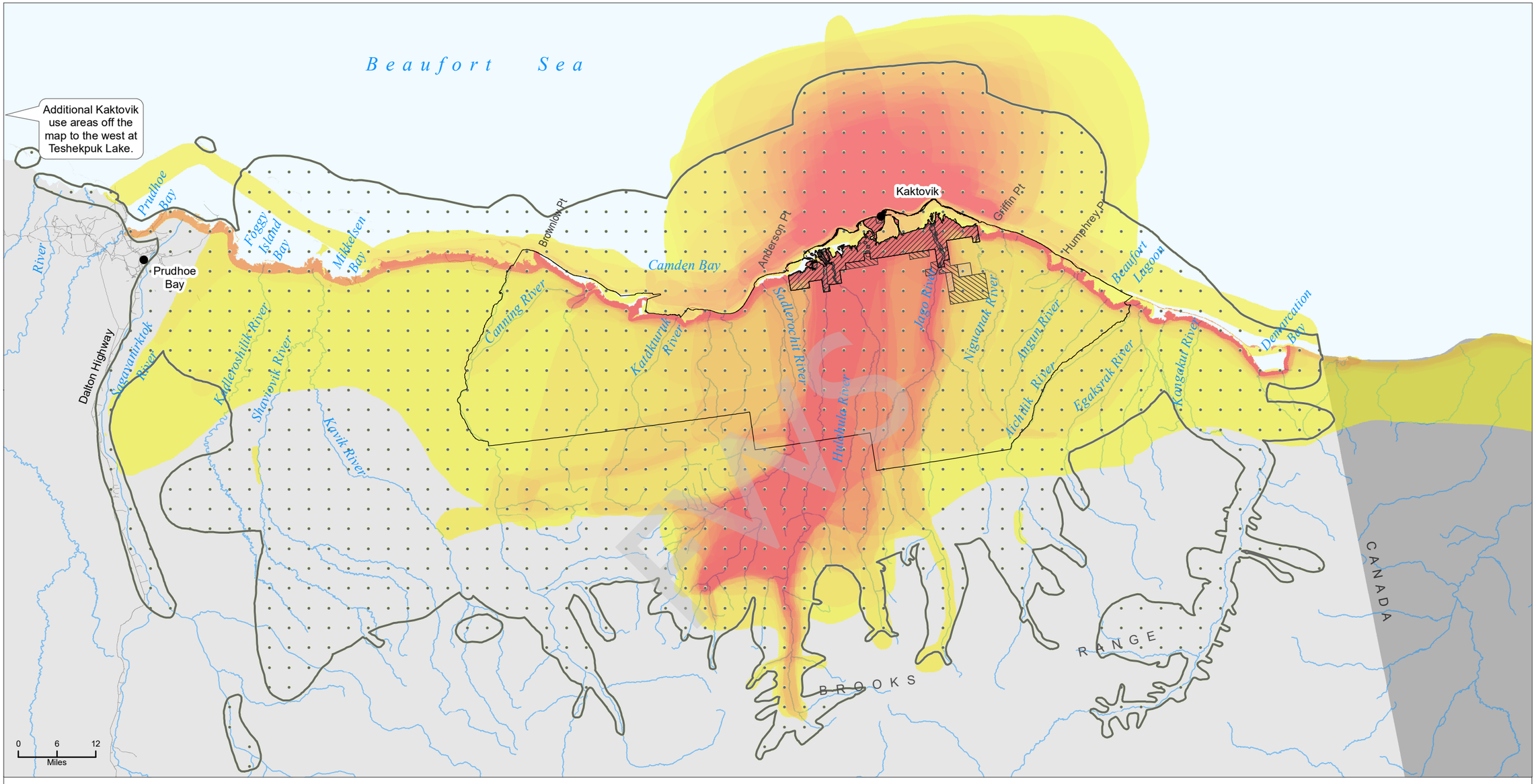
Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/07/2018

Map 3-25



All resources, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas all resources, 1996–2006

High

Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

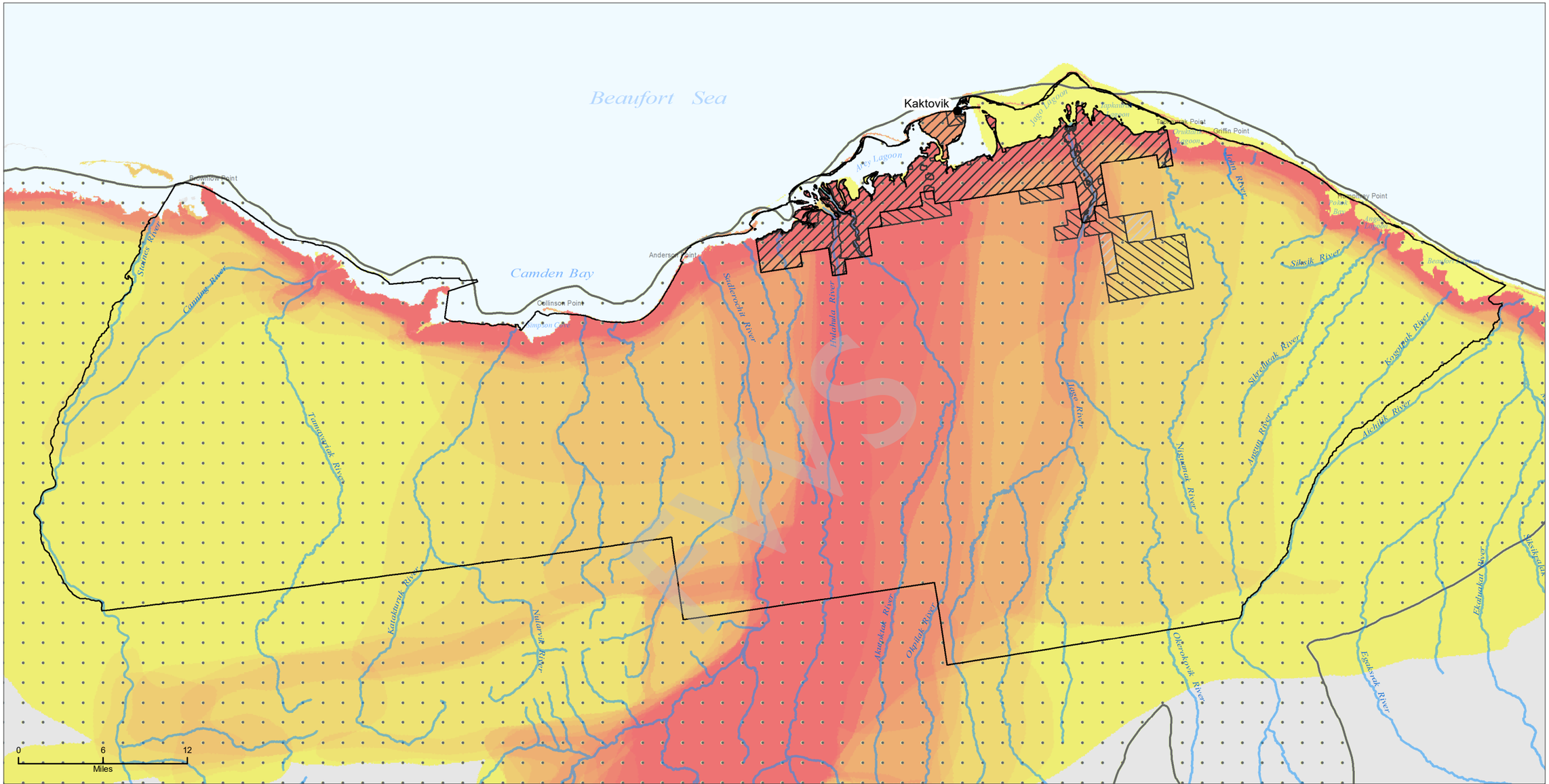
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-26



Caribou, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas caribou, 1996–2006
High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

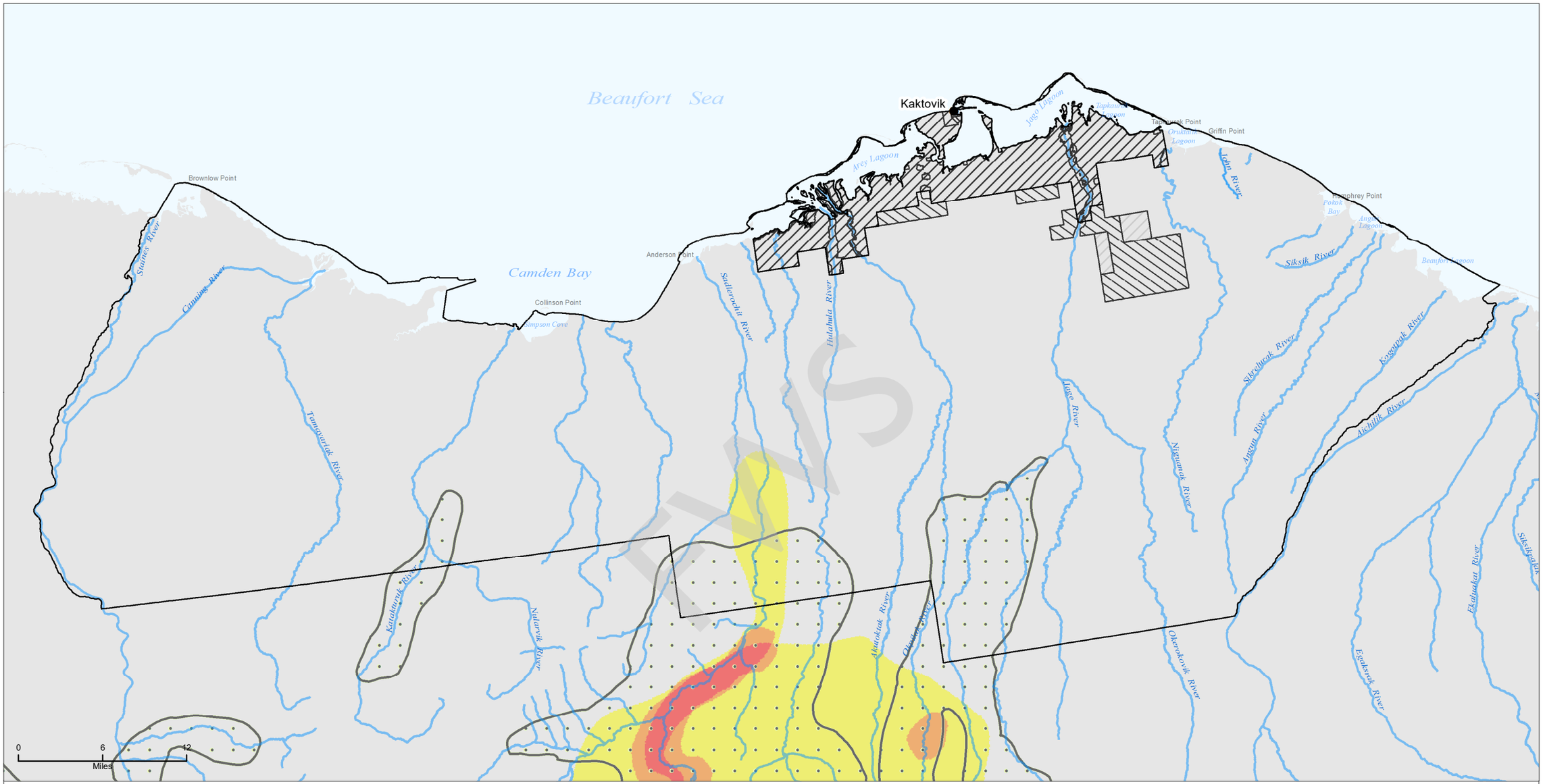
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-27



Moose, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas moose, 1996–2006
High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

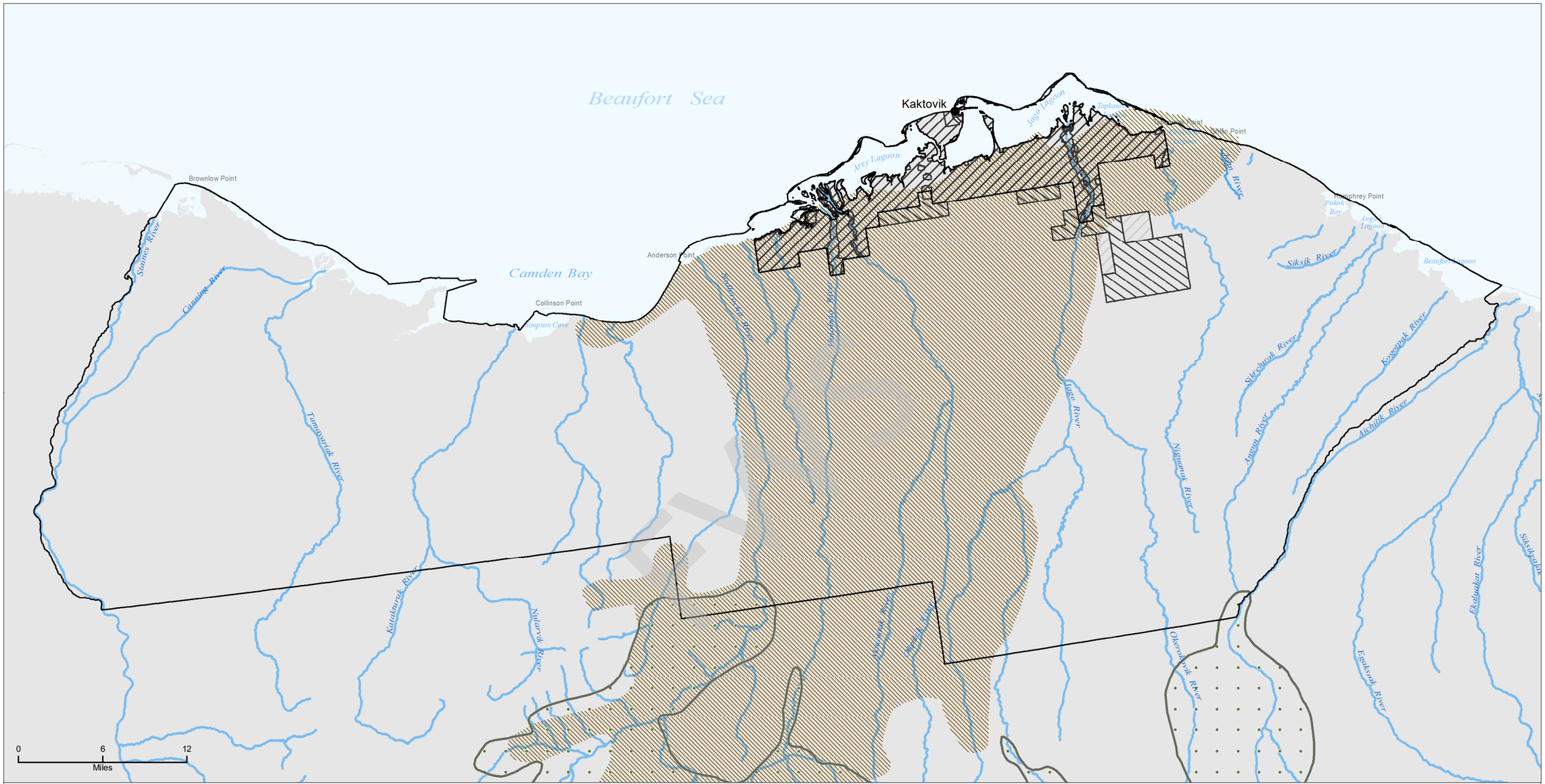
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-28

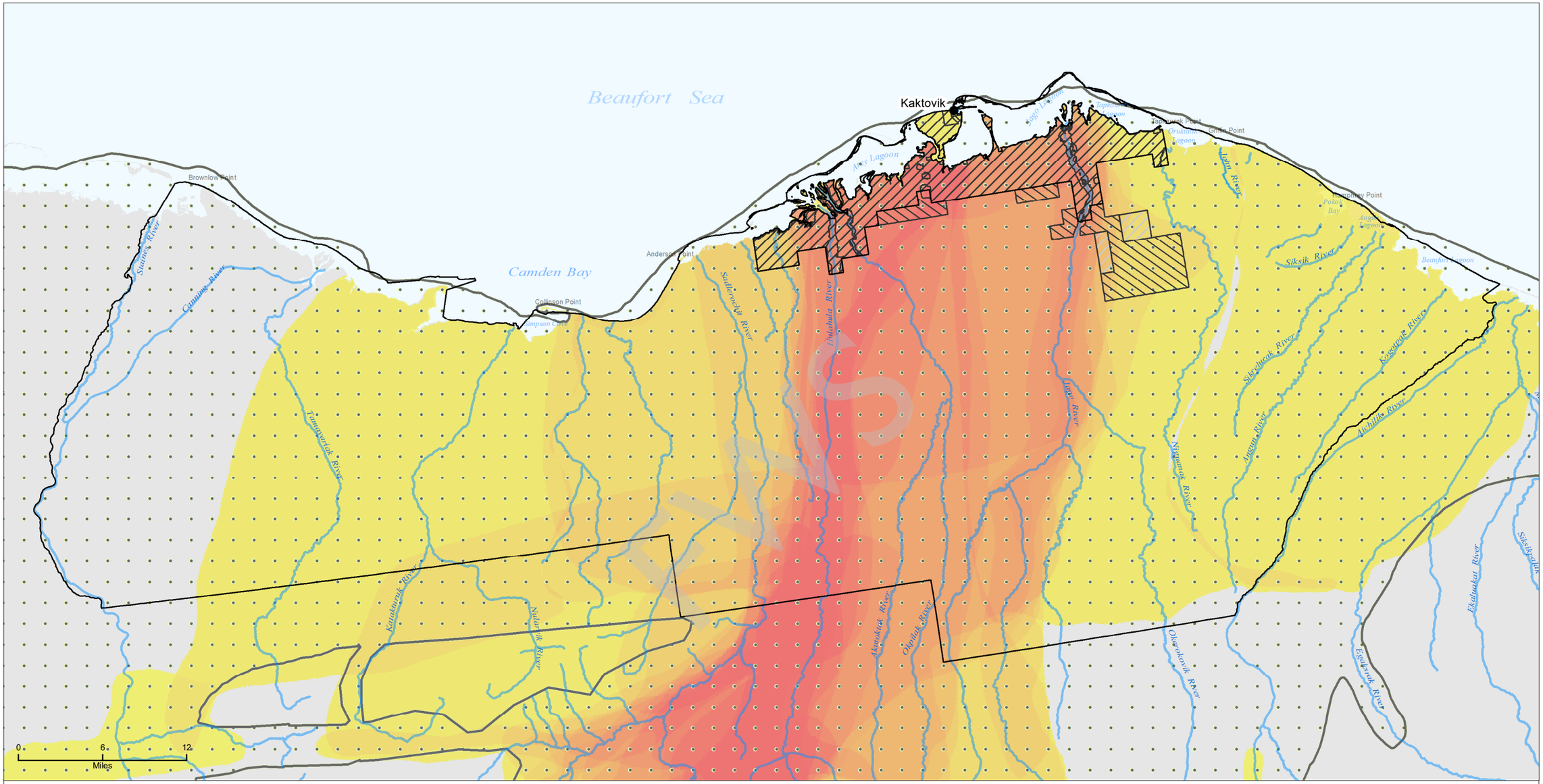


Sheep, lifetime prior to 1979[1]
Grizzly, lifetime prior to 1979[1]
Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-29



Furbearers, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas wolf and wolverine, 1996–2006

High

Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

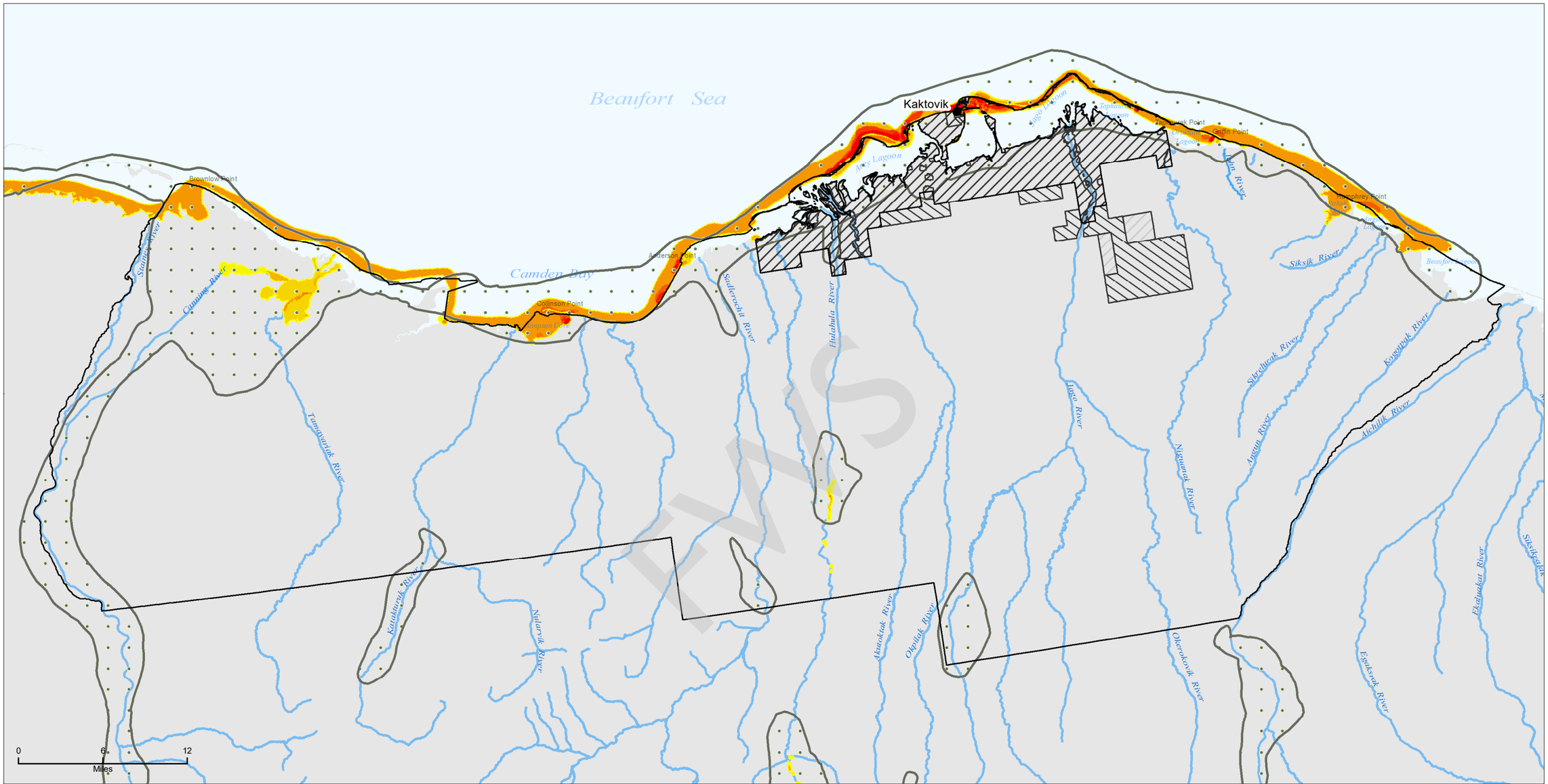
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen, Coffing and Thompson 1985 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-30



Fishing, lifetime prior to 1979[1]

Overlapping[2] subsistence use areas fish, 1996–2006

High

Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

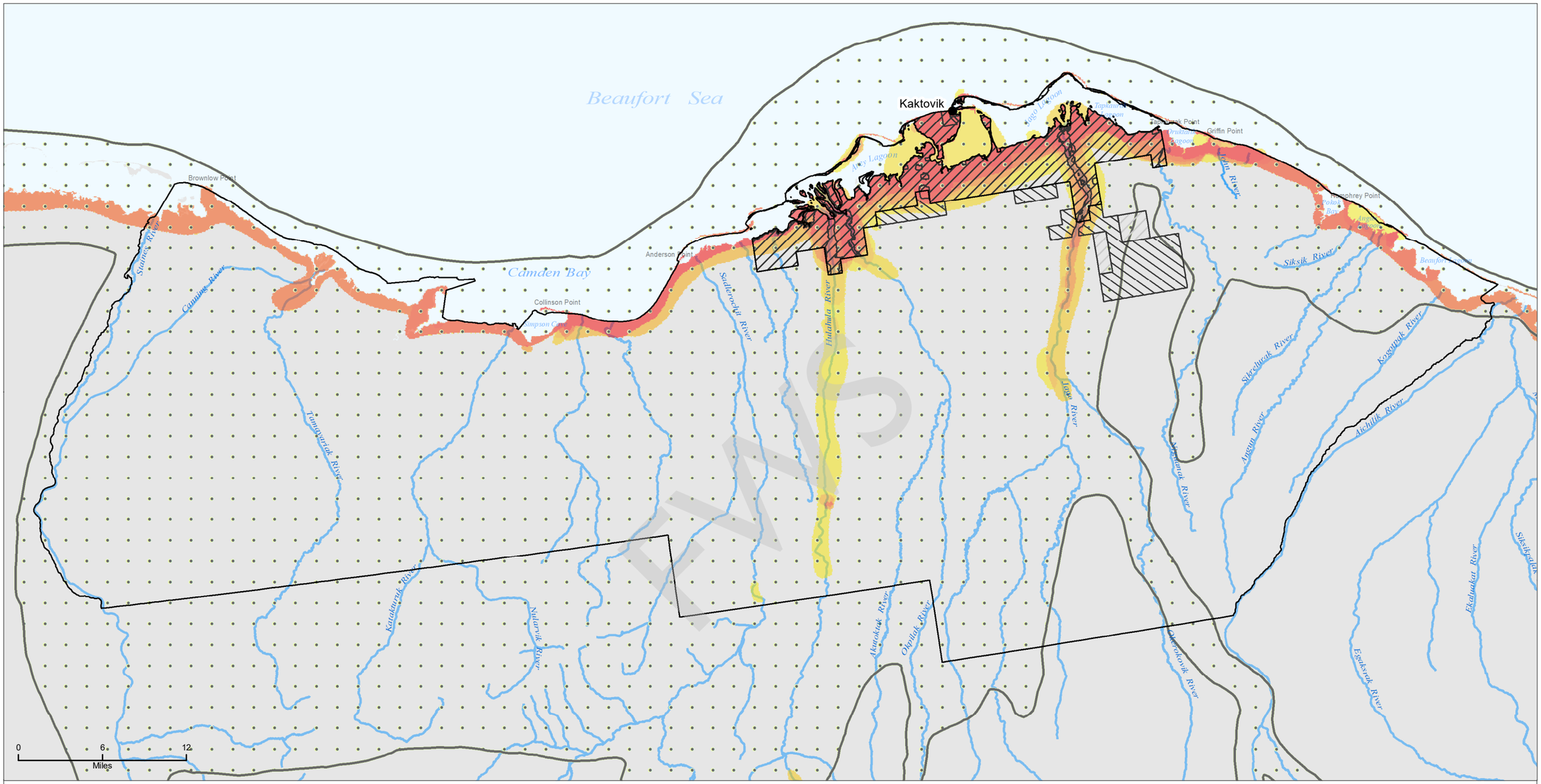
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-31



Wildfowl, lifetime prior to 1979[1]

Overlapping[2] subsistence use areas eider and goose, 1996–2006

High

Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

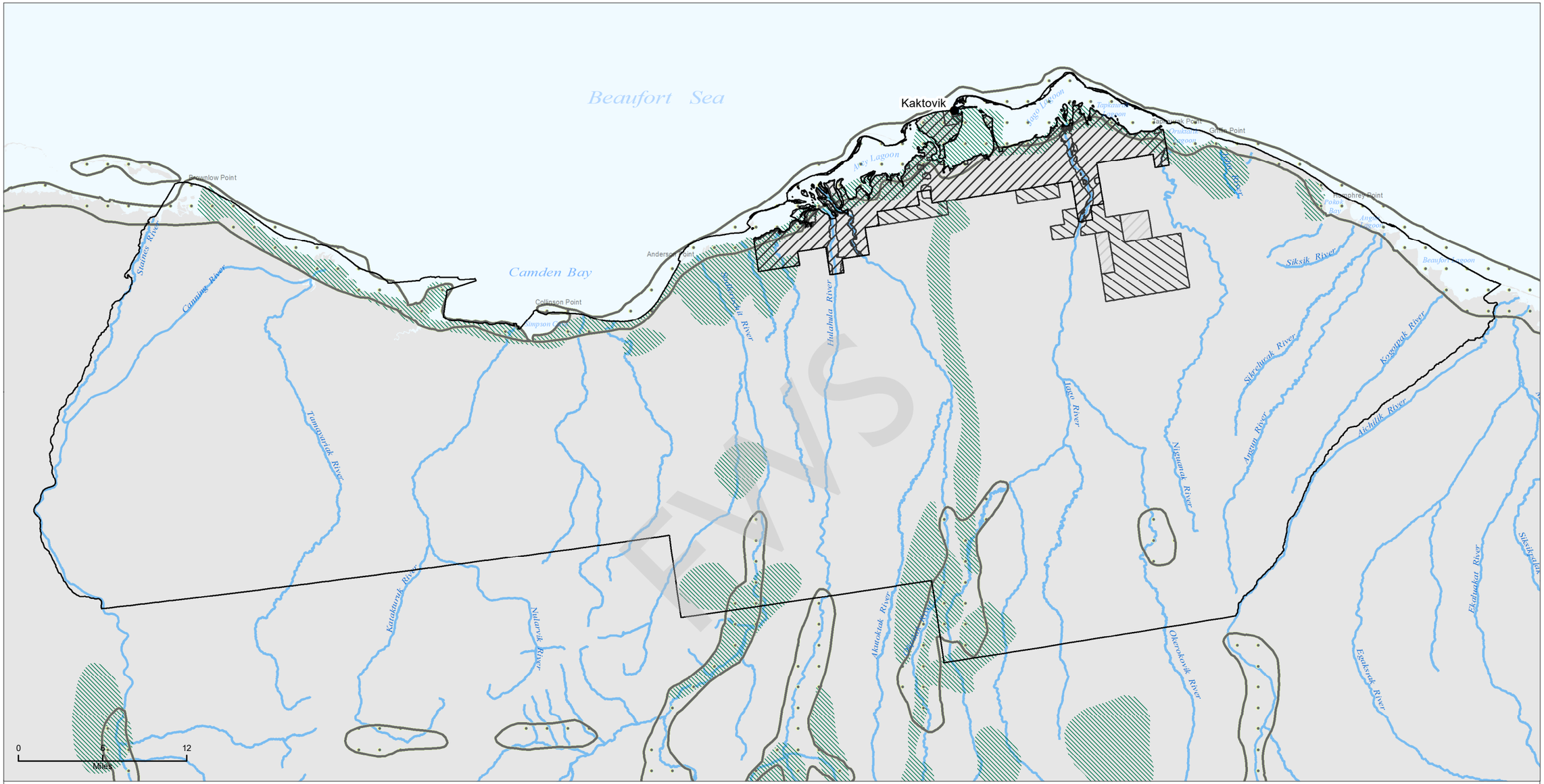
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-32



Vegetation, lifetime prior to 1979[1]

Wood, lifetime prior to 1979[1]

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

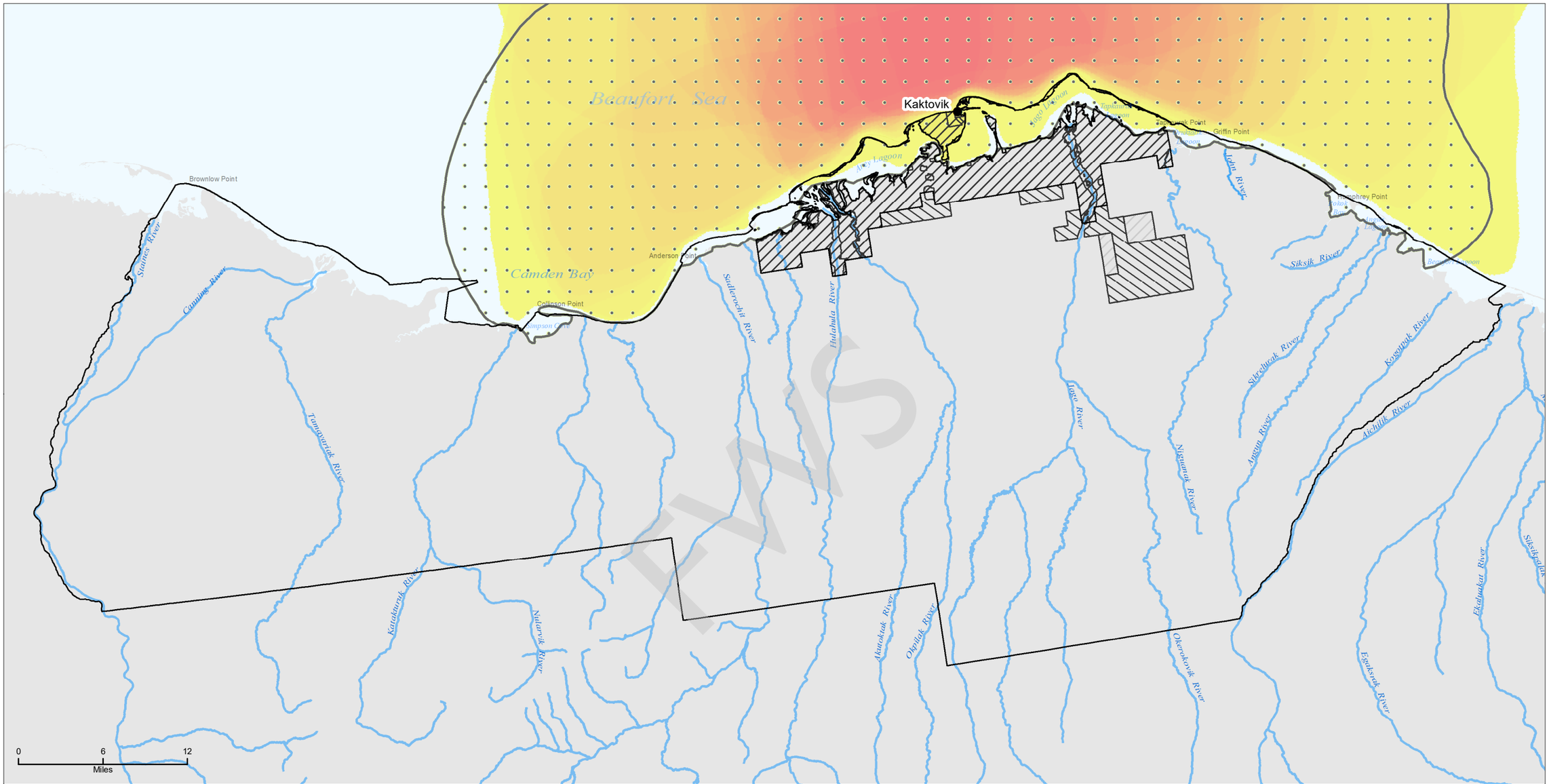
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-33



Whale, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas bowhead, 1996–2006
High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

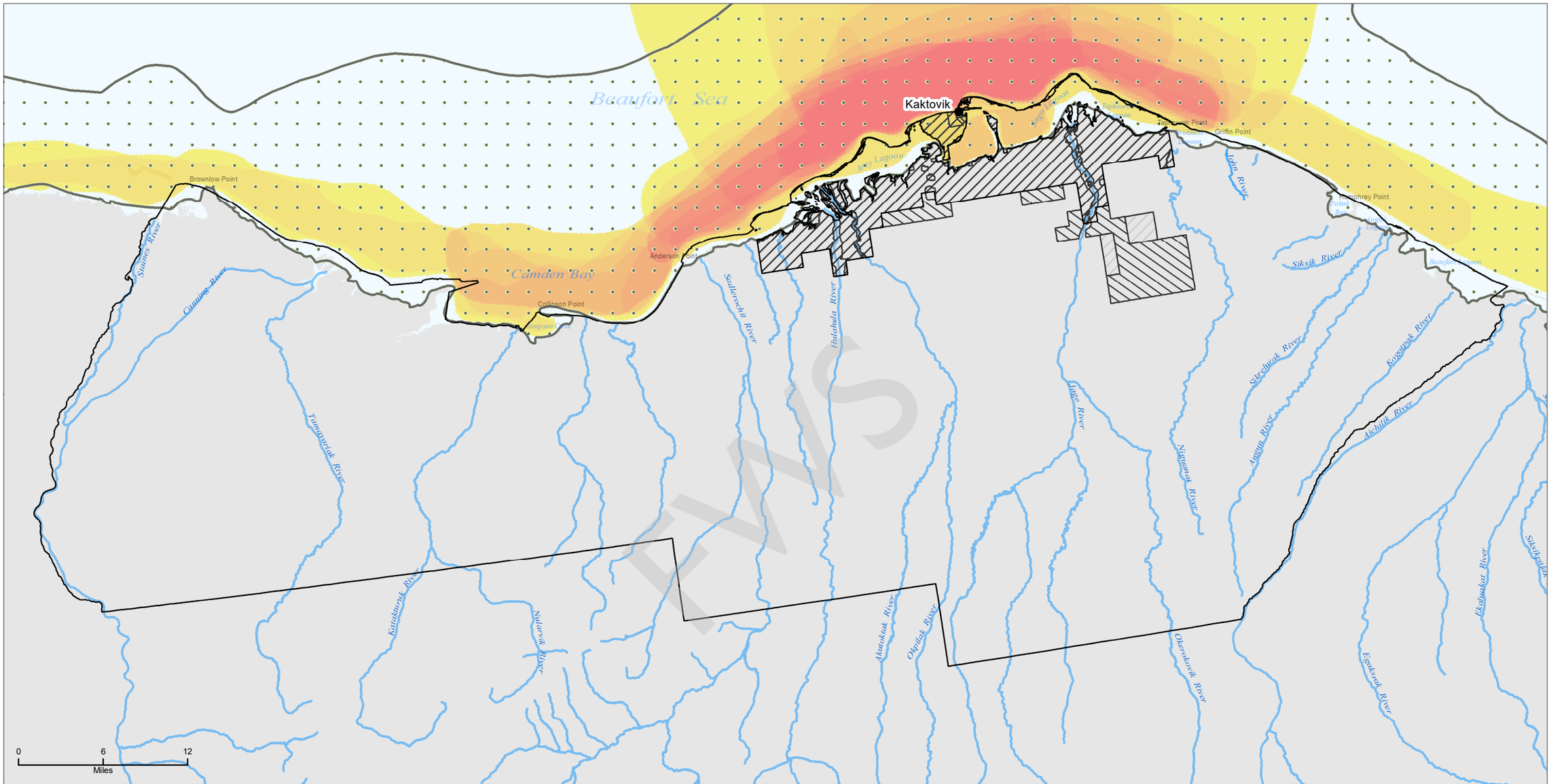
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-34



Seal, lifetime prior to 1979[1]

Overlapping[2] subsistence use areas seal, 1996–2006

High

Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

Native-selected

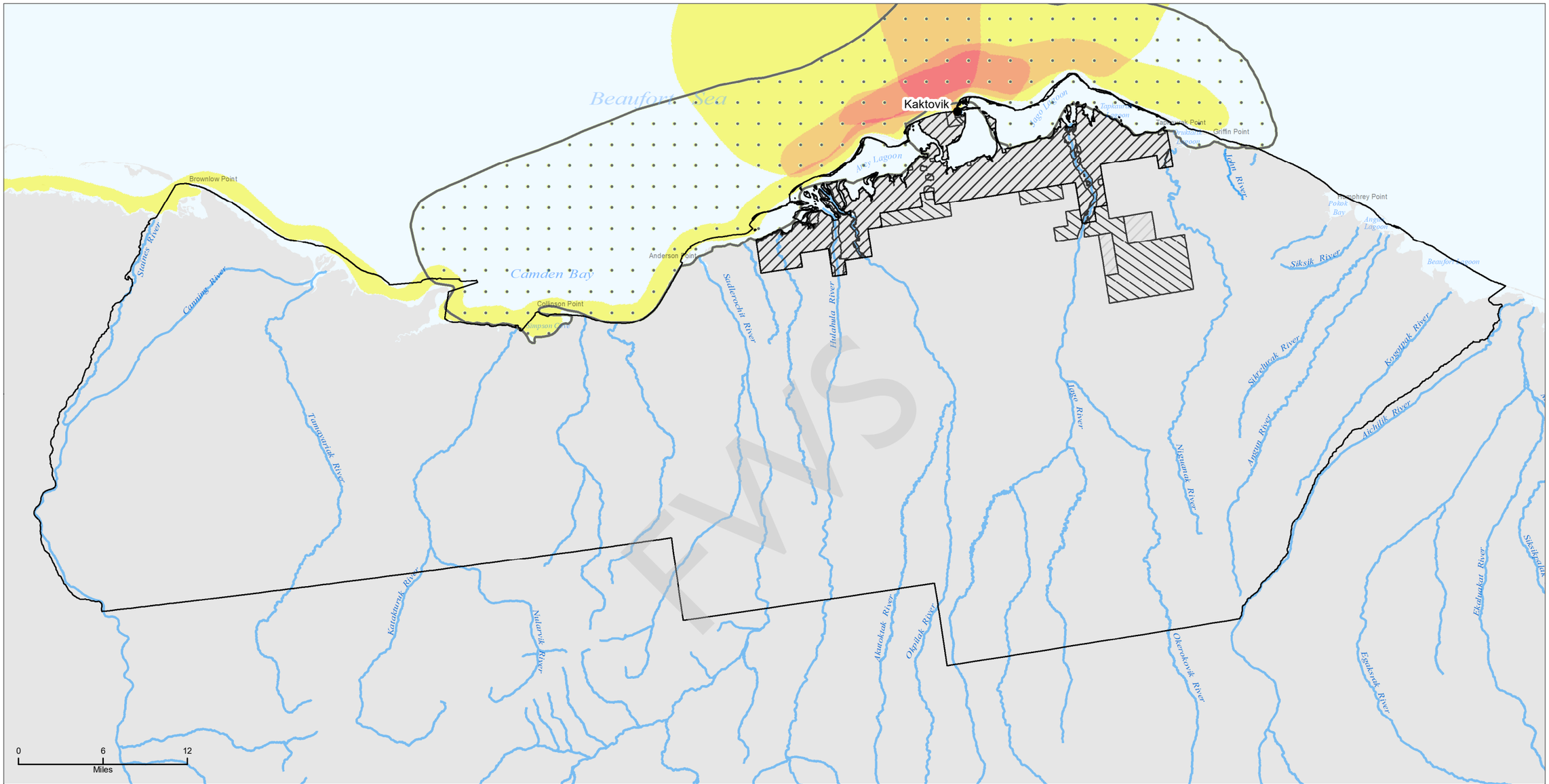
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates

Print Date: 08/06/2018

Map 3-35



Walrus, lifetime prior to 1979 [1]

Overlapping [2] subsistence use areas walrus, 1996–2006
High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

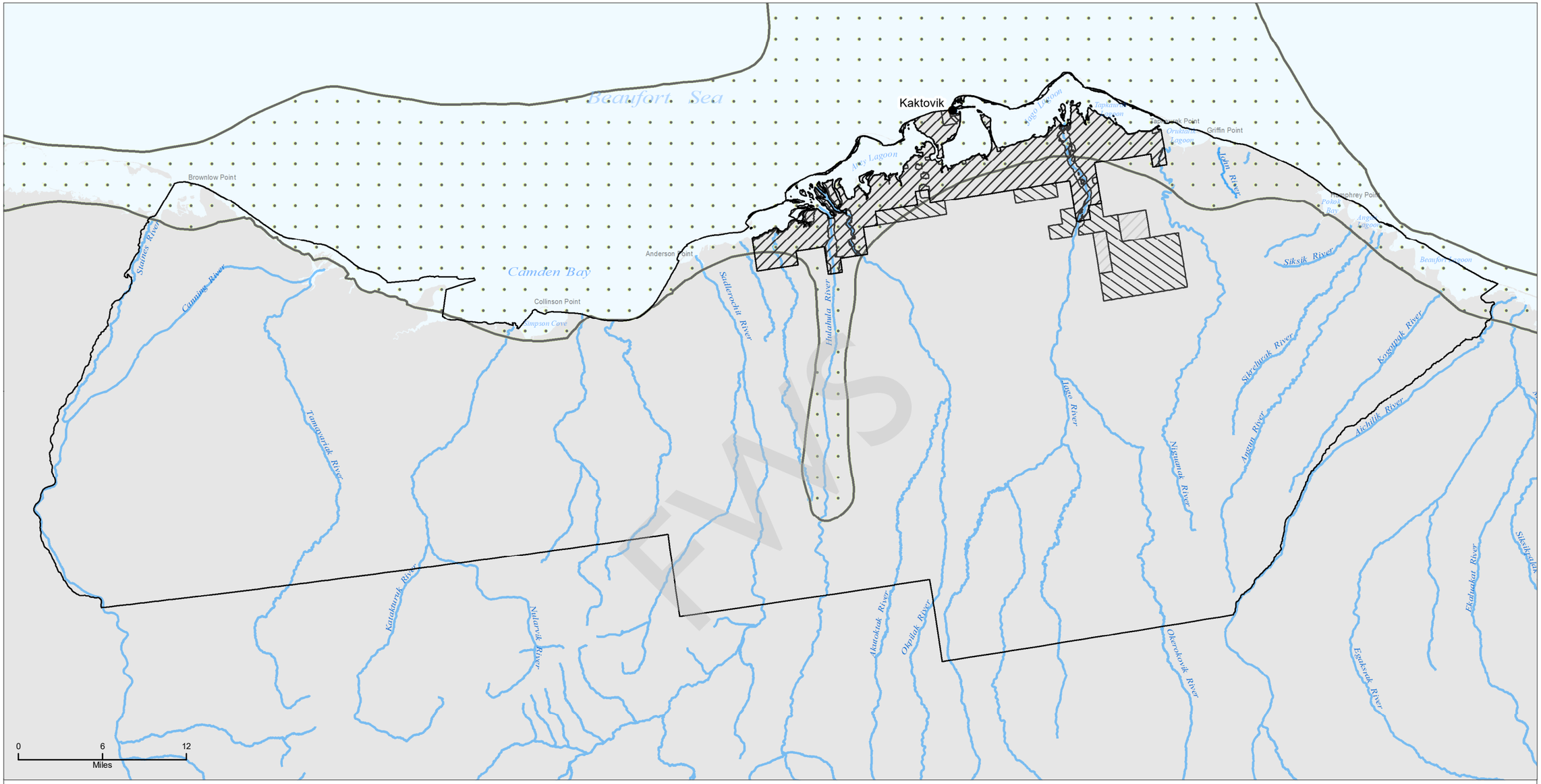
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979 2) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-36



Polar bear, lifetime prior to 1979 [1]

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

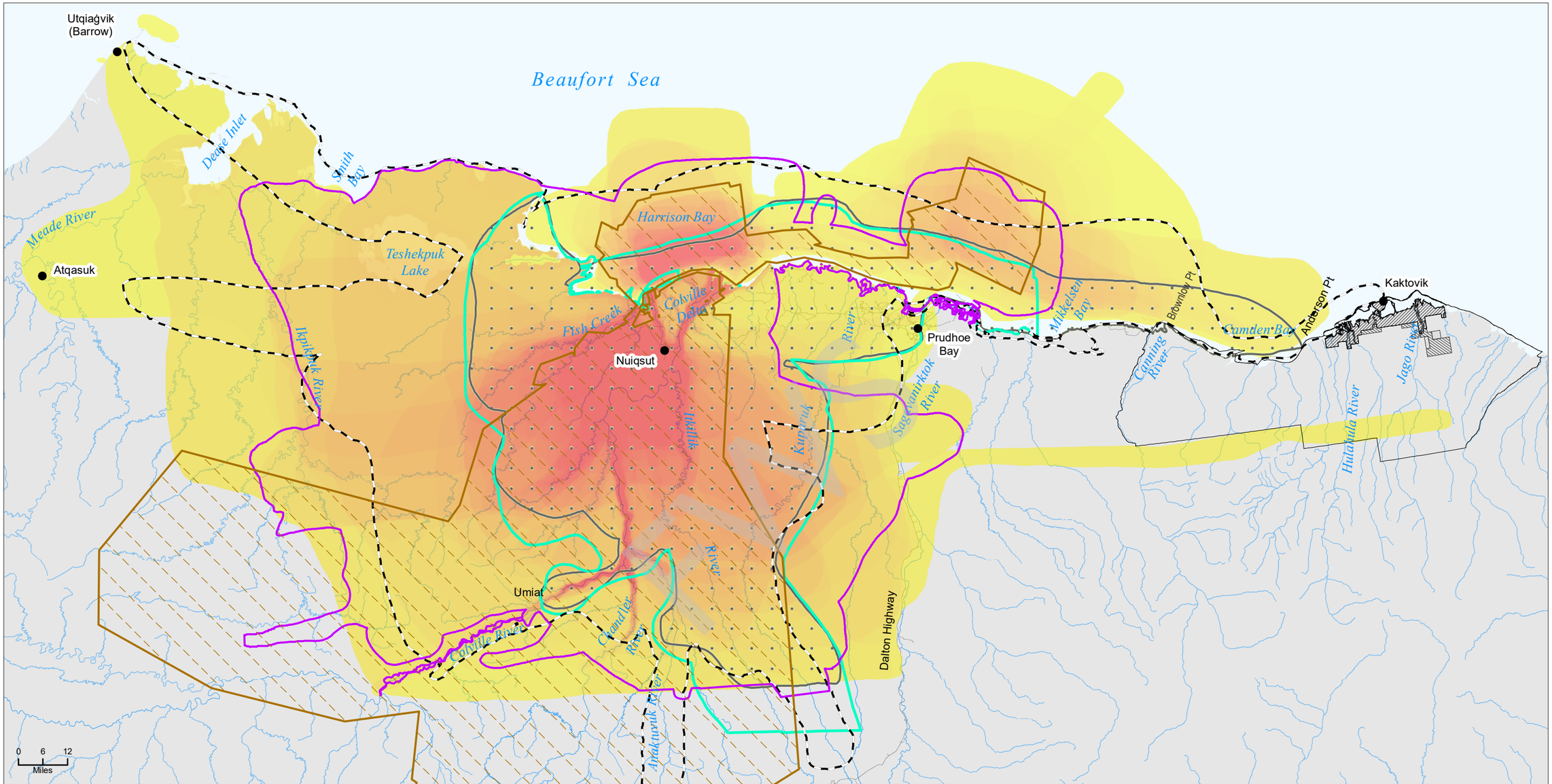
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1979

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-37



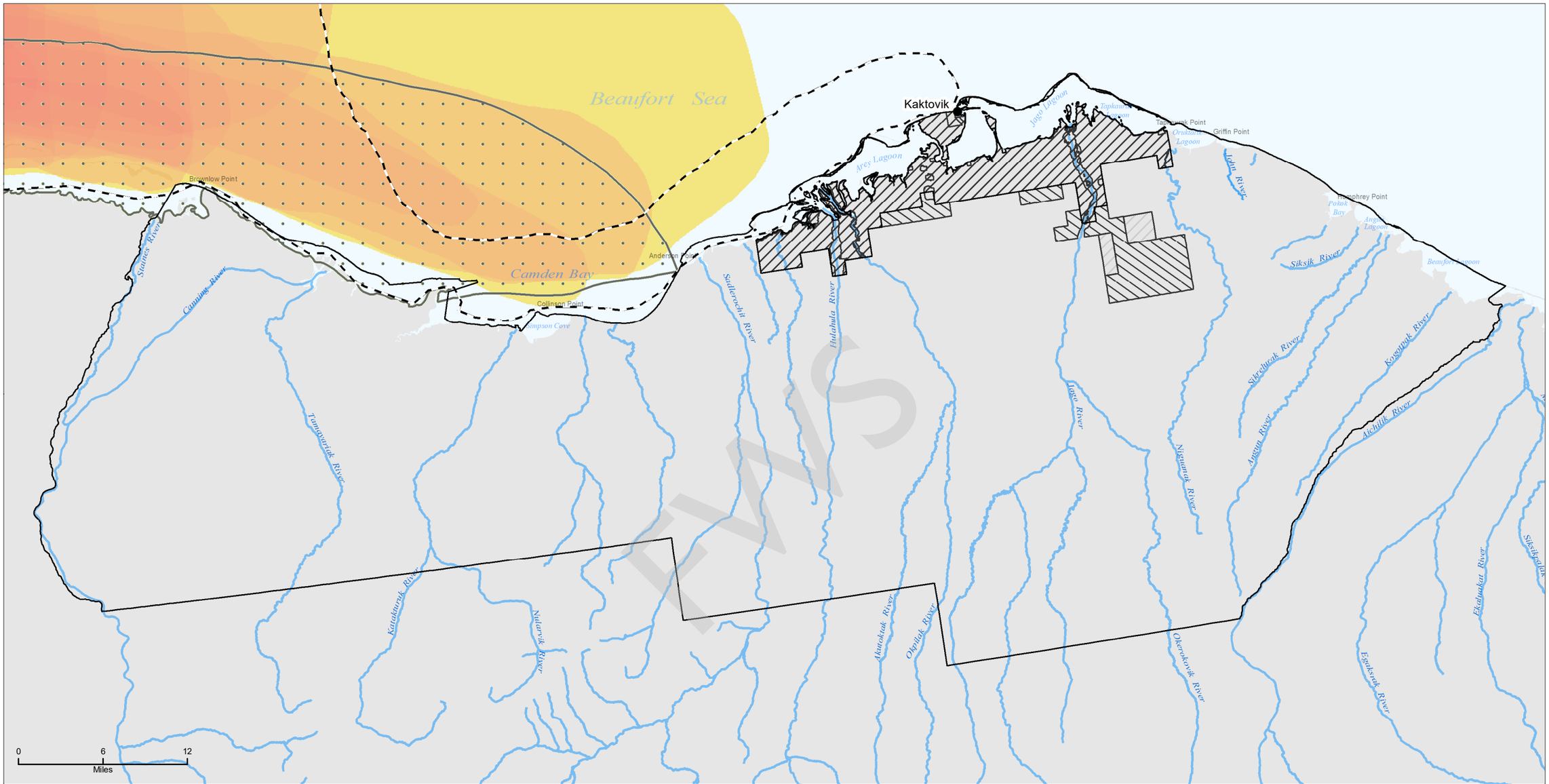
All resources, 2014 [1]
All resources, 1994–2003 [2]
All resources, 1973–1986 [3]
All resources, early 1970s [4]
All resources, lifetime prior to 1979 [5]
High
Low
Overlapping subsistence use areas all resources, 1995–2006 [6]

Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

Data Source: BLM GIS 2018, 1) Brown et al. 2016 2) BLM 2004 3) Pedersen 1986 4) Brown 1979 5) Pedersen 1979 6) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-38

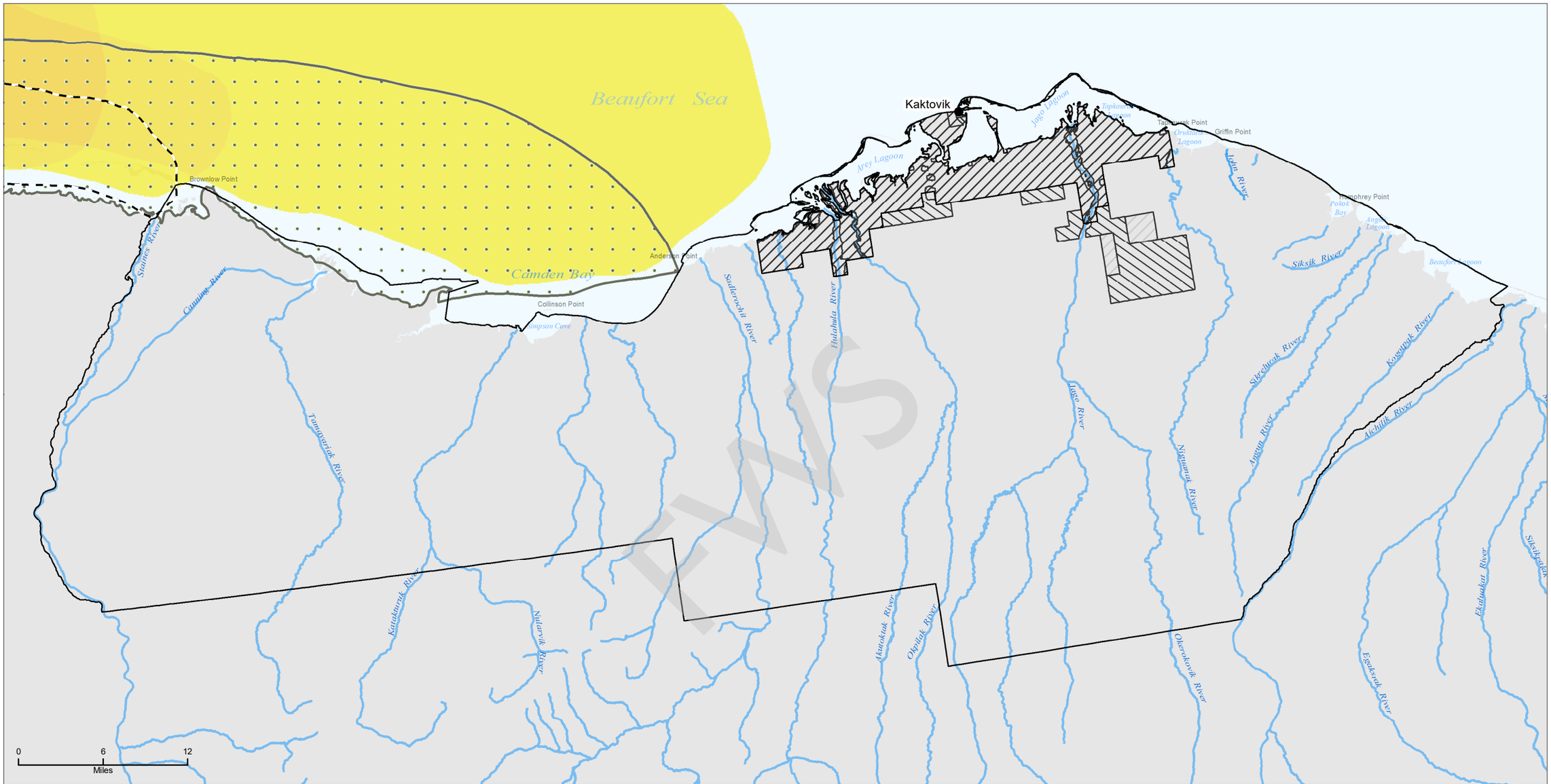


Whaling, 1973–1986[1]
Whales, lifetime prior to 1979[2]
Overlapping[3] subsistence use areas bowhead, 1995–2006
High
Low
Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1986 2) Pedersen 1979 3) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-39



Seal, 1973–1986[1]

Seal, lifetime prior to 1979[2]

Overlapping[3] subsistence use areas seal, 1995–2006
High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

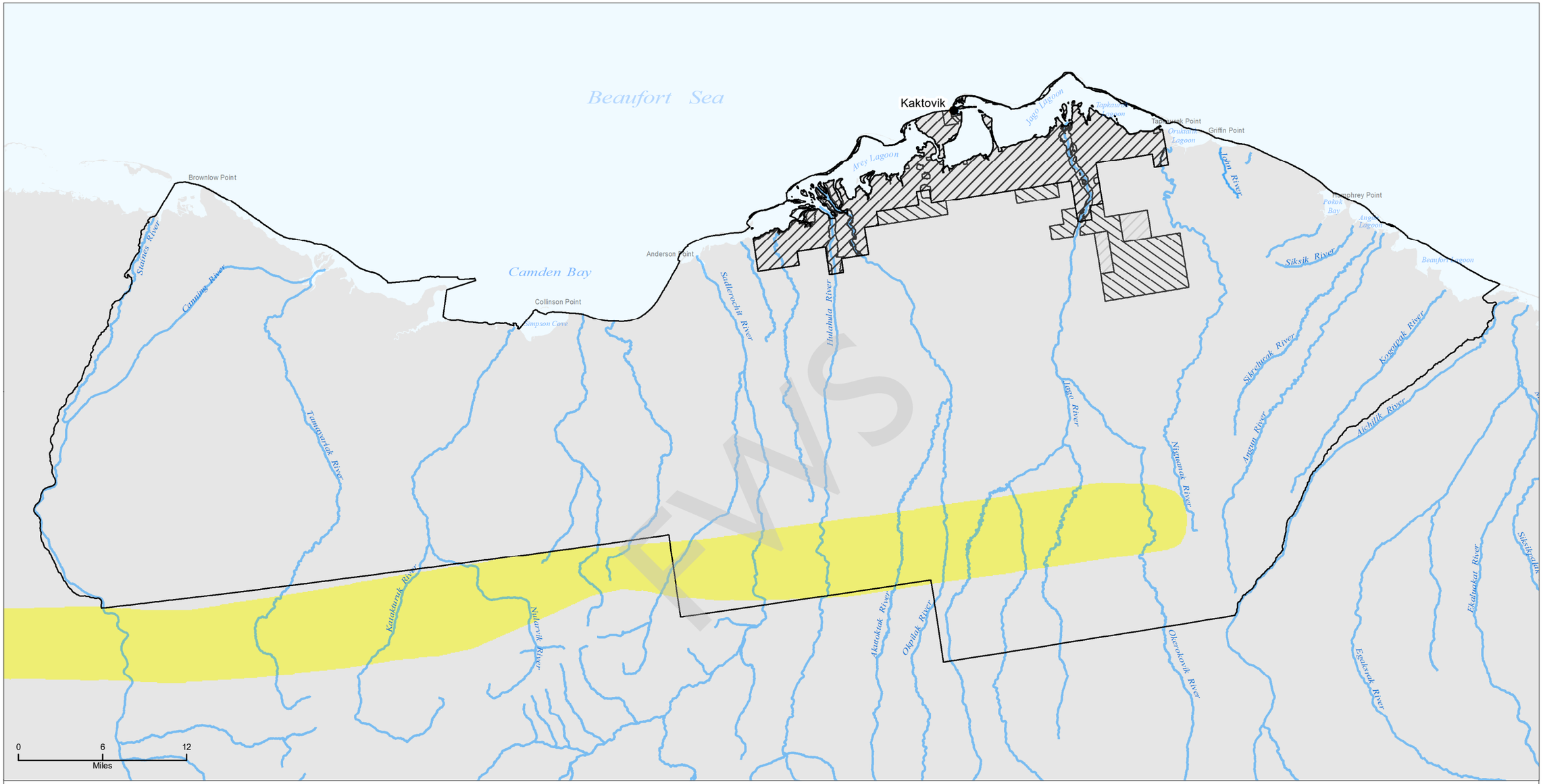
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Pedersen 1986 2) Pedersen 1979 3) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-40



Overlapping subsistence use areas wolf and wolverine, 1995–2006 [1]

High
Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

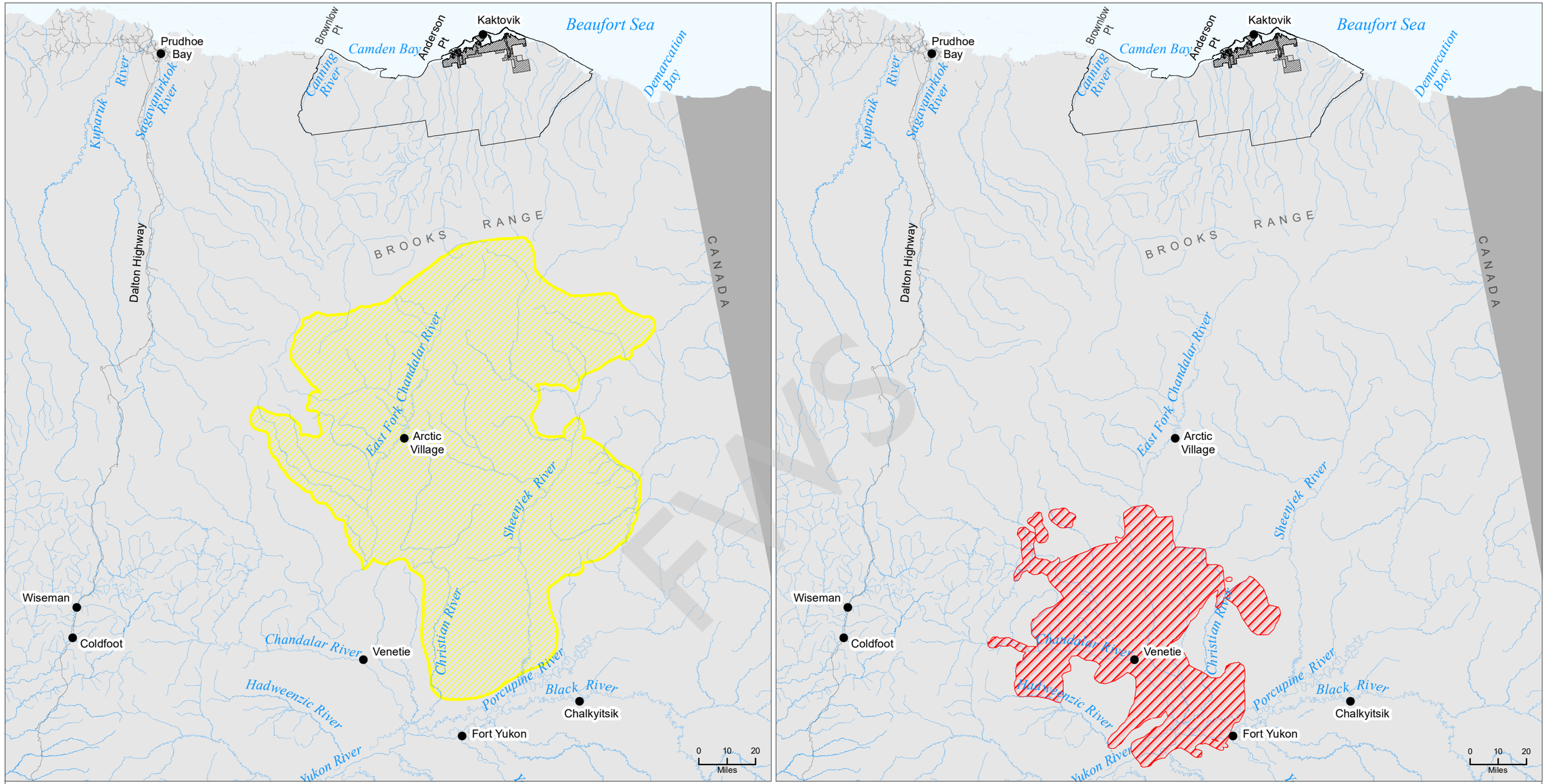
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-41



Arctic Village, all resources, lifetime prior to 1980 [1]

Venetie, all resources, lifetime prior to 1981 [1]

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:

Excluded from Public Law 115-97 Coastal Plain

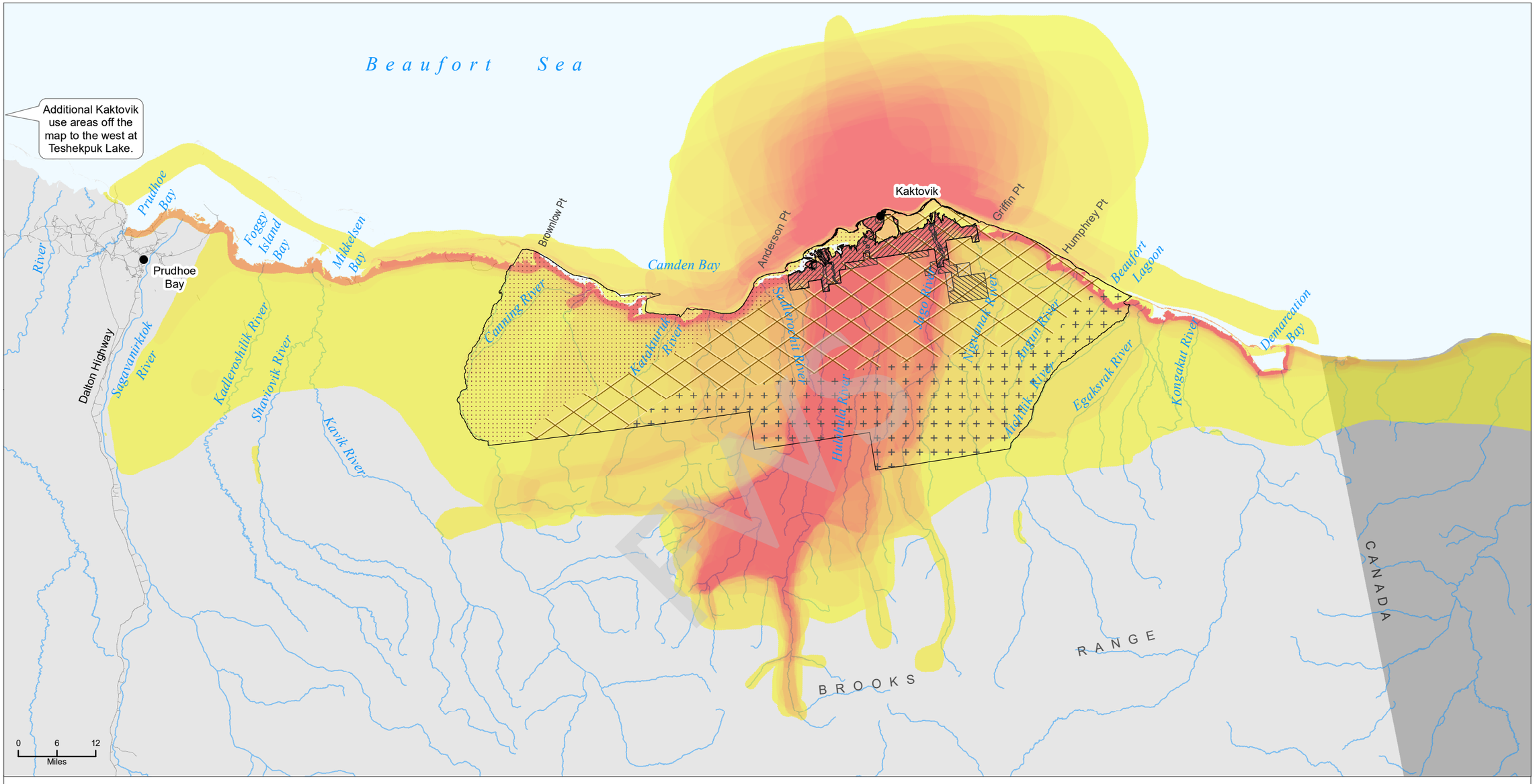
Native-selected

Interim conveyed land

Data Source: BLM GIS 2018, 1) Caulfield 1983

Map Prepared By: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-42



Overlapping [1] subsistence use areas all resources, 1996–2006

High

Low

- High hydrocarbon potential
- Medium hydrocarbon potential
- Low hydrocarbon potential

- Public Law 115-97 Coastal Plain

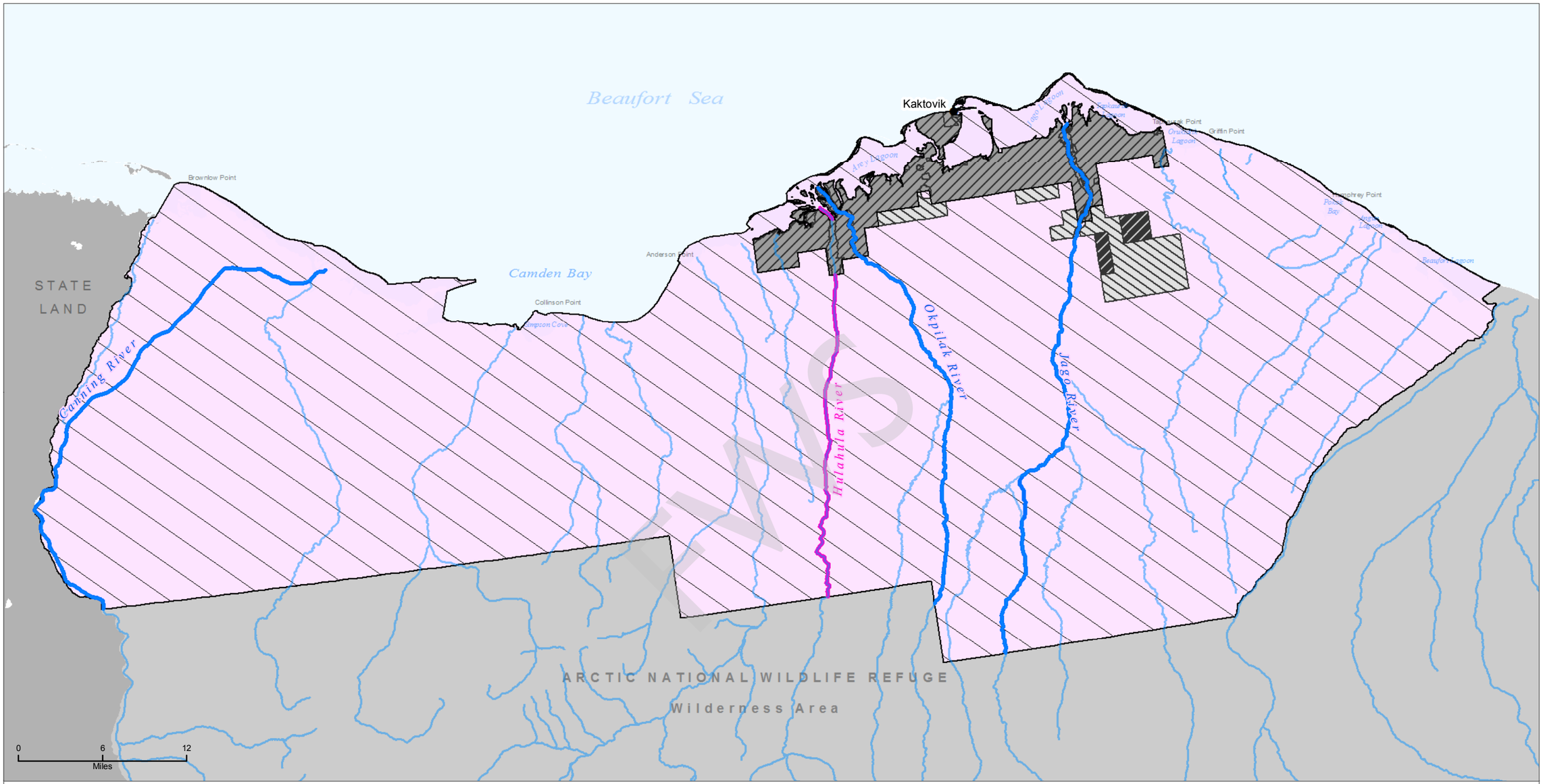
Outside BLM's oil and gas leasing authority:

- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018, 1) SRB&A 2010

Map prepared by: Stephen R. Braund & Associates
Print Date: 08/06/2018

Map 3-43

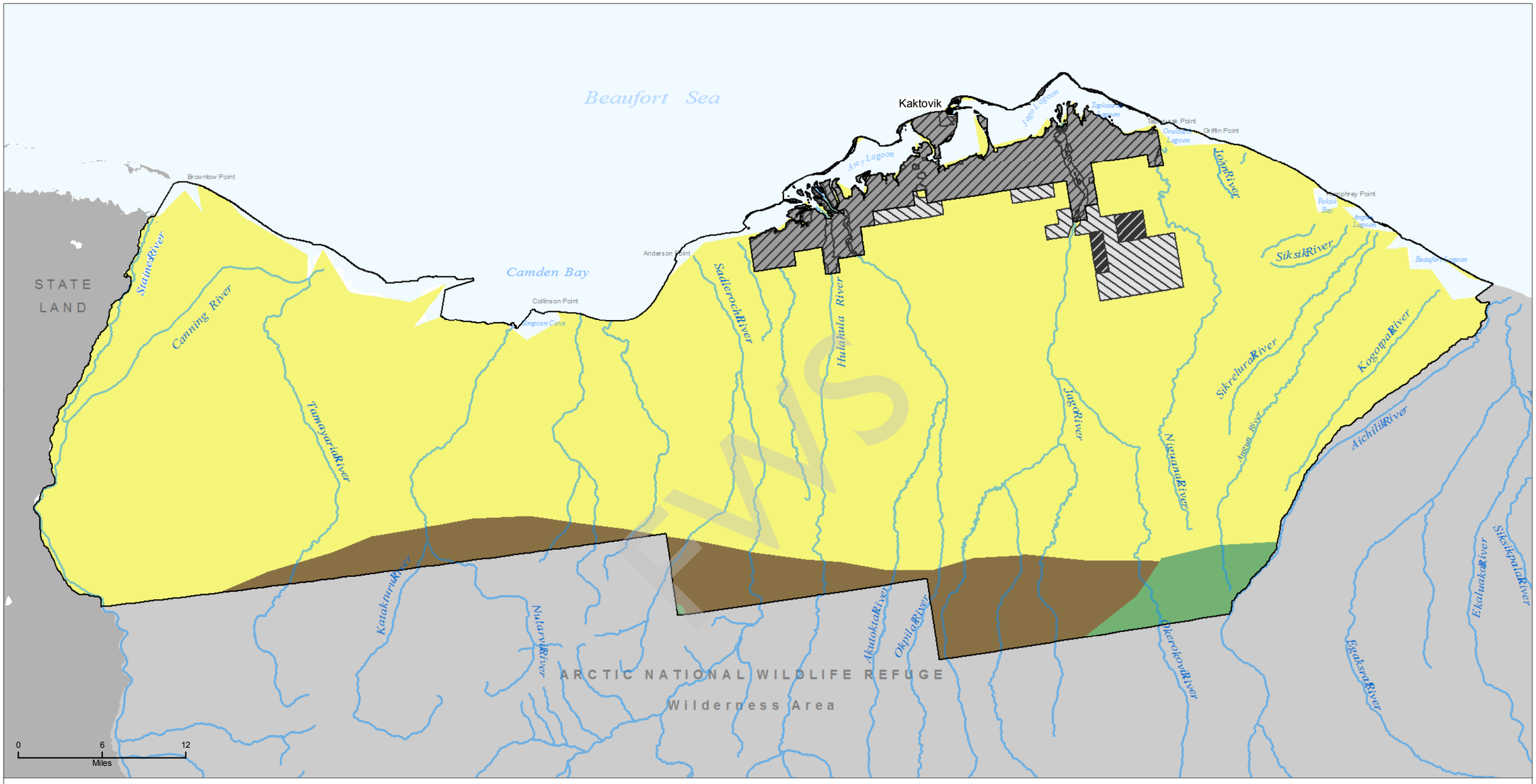


Wild and scenic river suitable
Wild and scenic river eligible
Marine protected area
Minimal management

Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

Data Source: BLM GIS 2018, NOAA GIS 2017, USFWS GIS 2015
Print Date: 08/08/2018

Map 3-44

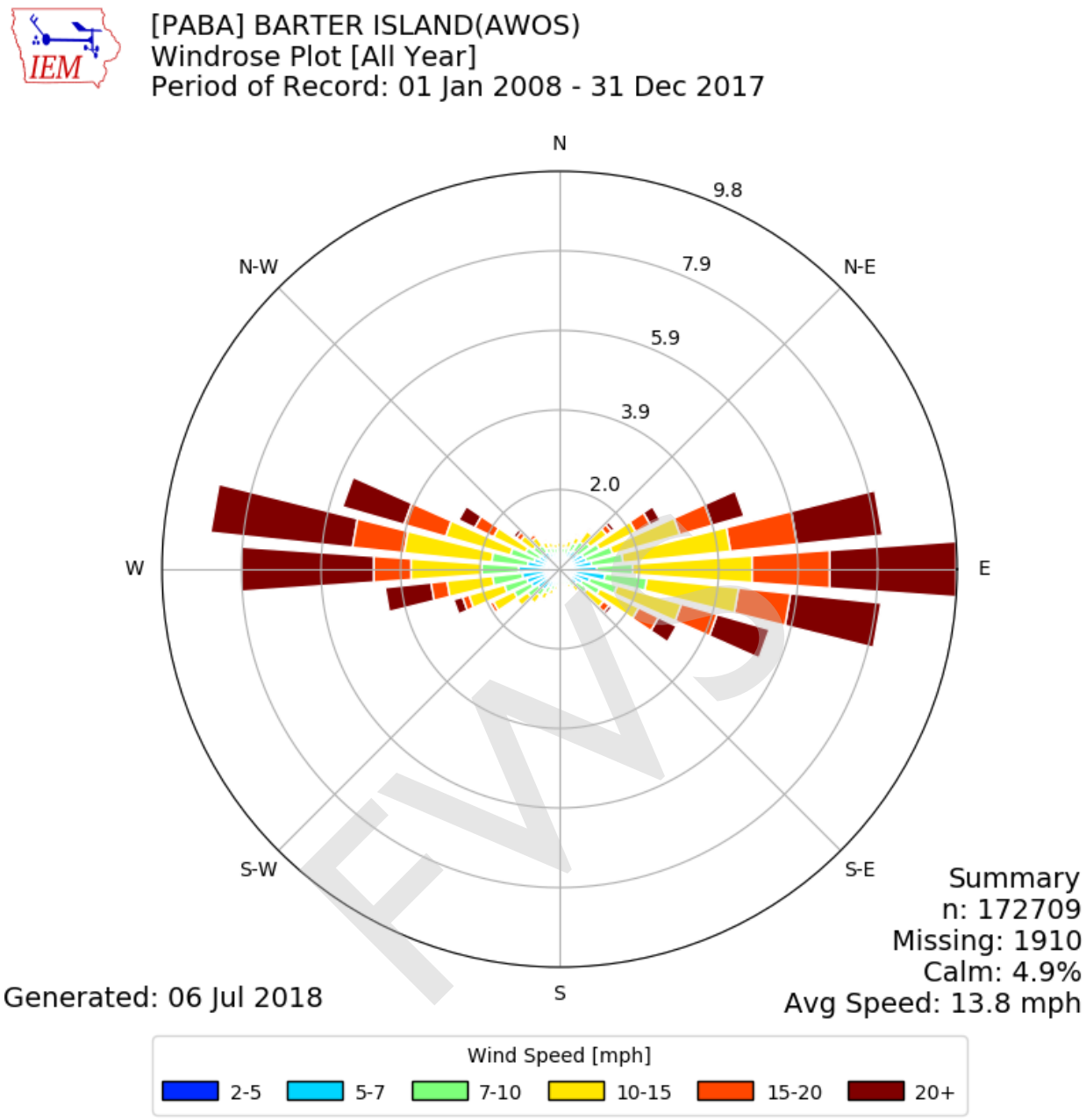


Arctic Coastal Plain
Arctic foothills
Ambler-Chandalar Ridge and lowland

Public Law 115-97 Coastal Plain
Outside BLM's oil and gas leasing authority:
Excluded from Public Law 115-97 Coastal Plain
Native-selected
Interim conveyed land

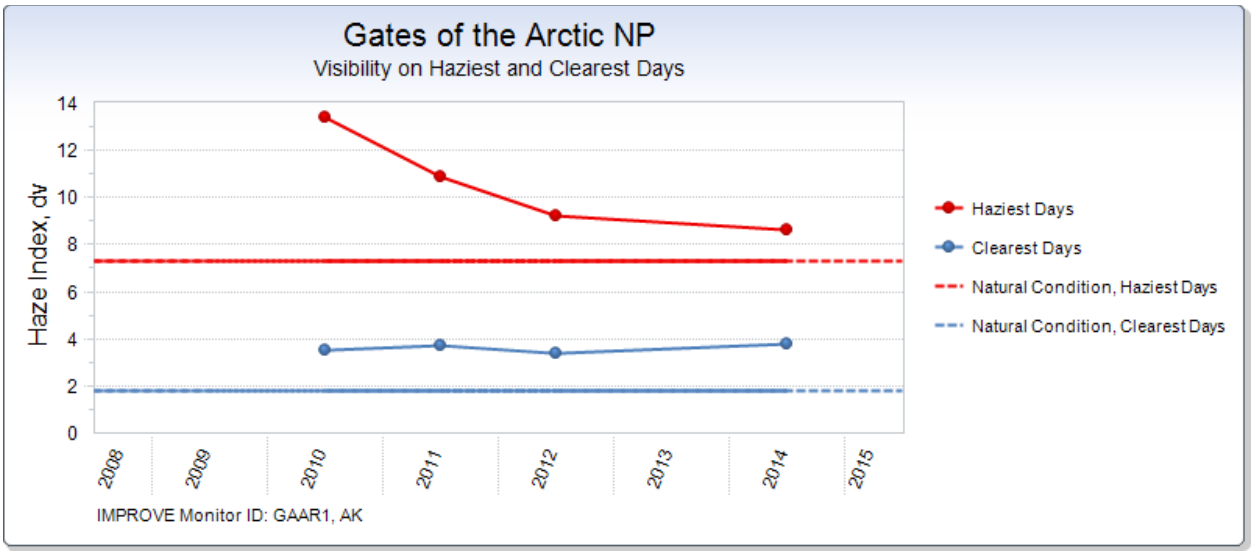
Data Source: BLM GIS 2018, Wahrhaftig GIS 1965
Print Date: 08/08/2018

Map 3-45



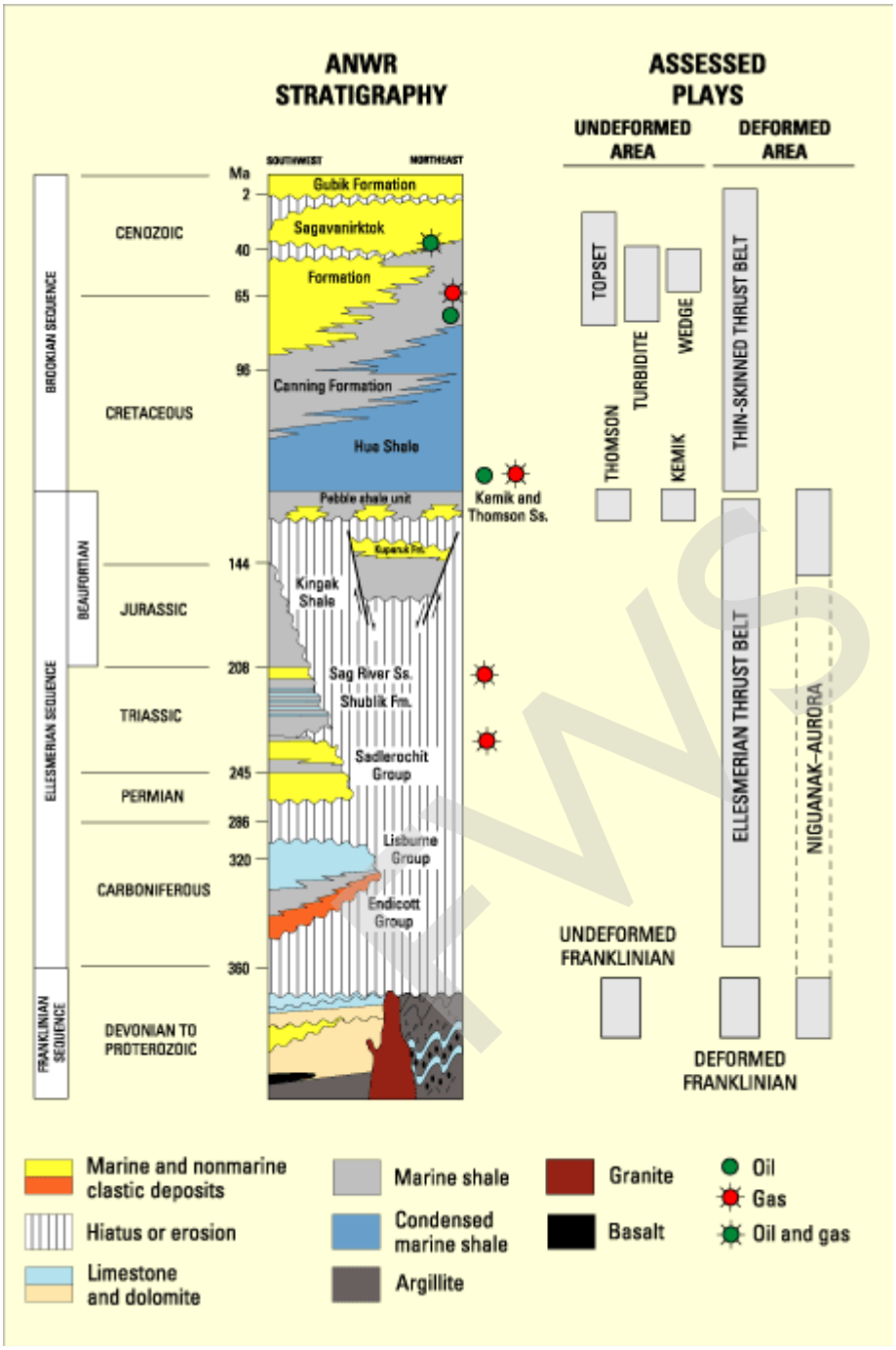
Source: Iowa State University (copyright: used with permission), Iowa Environmental Mesonet (IEM) website: http://mesonet.agron.iastate.edu/

Figure 3-1: Wind Rose Plot for Barter Island, Kaktovik, Alaska



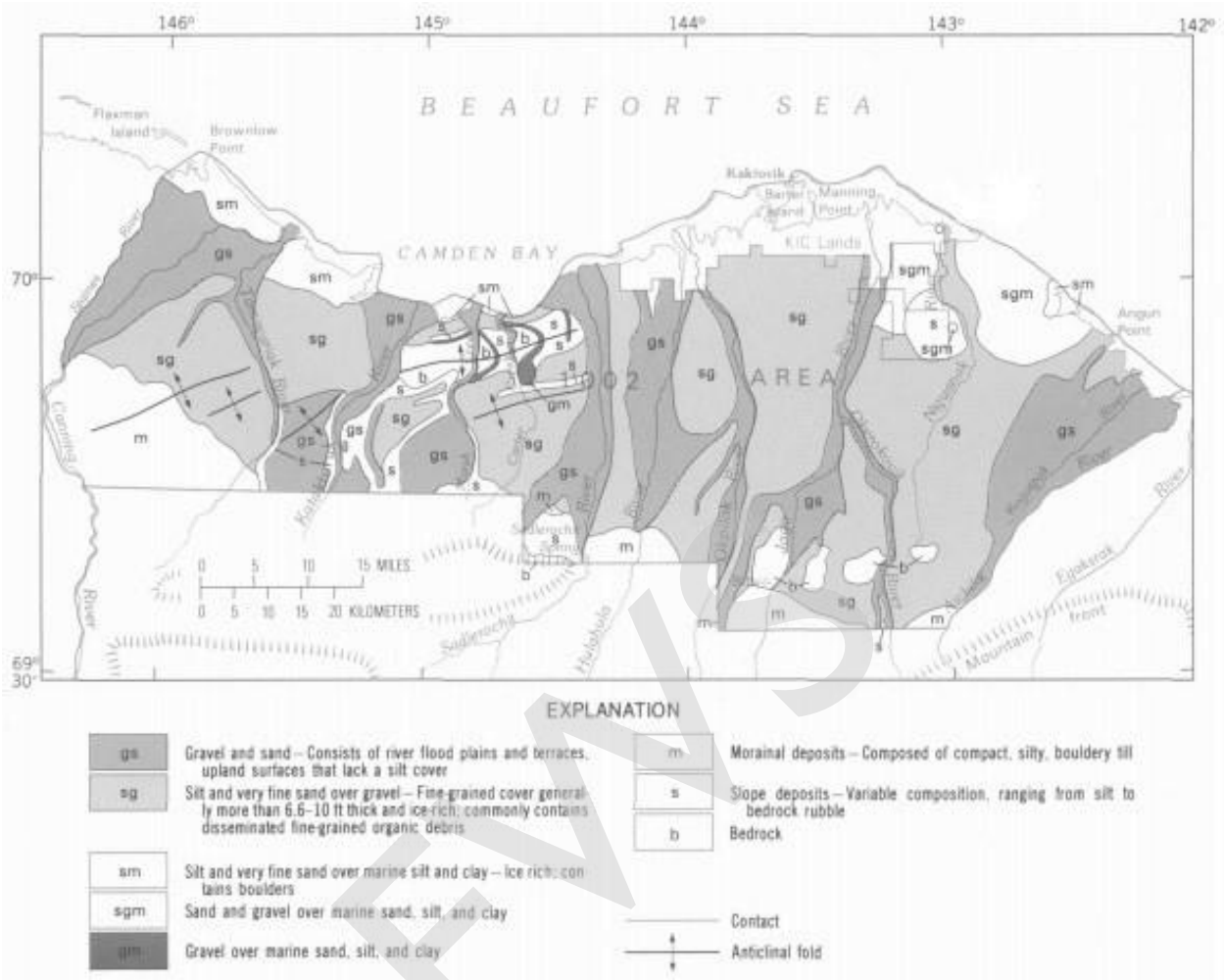
Source: IMPROVE 2018a

Figure 3-2: Visibility data for Gates of the Arctic National Park



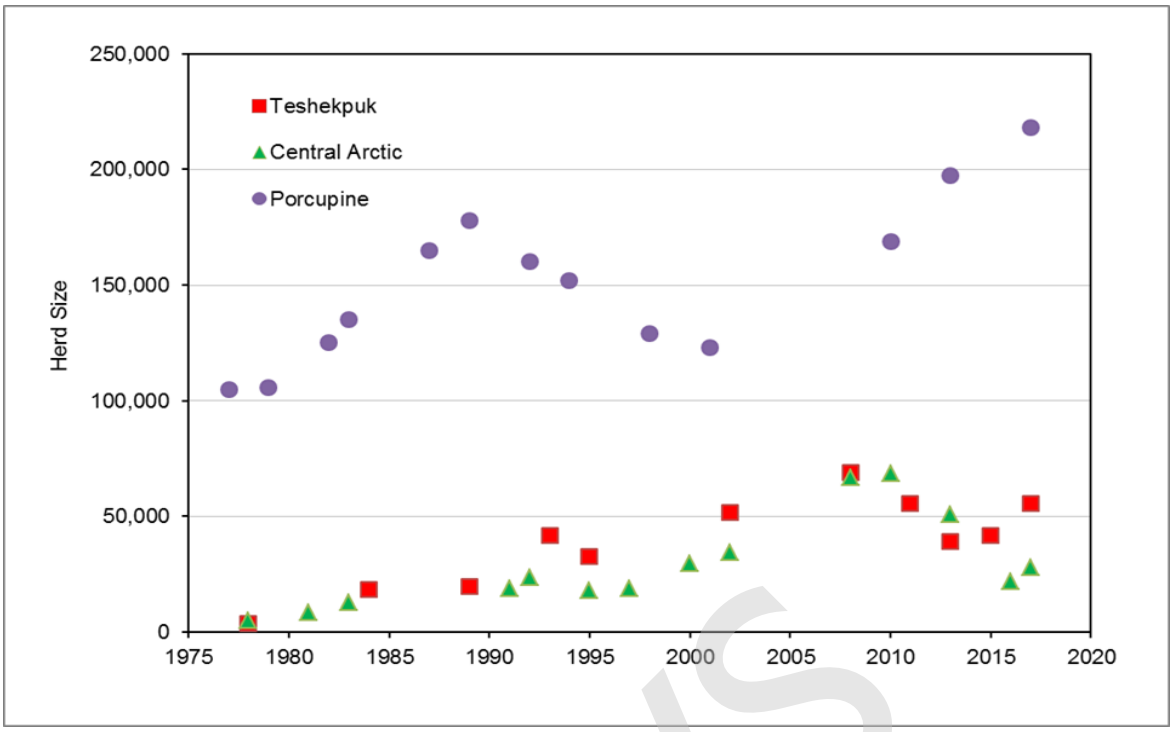
Source: US Geological Survey (USGS 1998) Fact Sheet 0028-02 Figure 3

Figure 3-3: Stratigraphy of the Coastal Plain



Source: Clough et al. 1987

Figure 3-4: Generalized Surficial Deposits of the Coastal Plain Area



Source: based on ADFG photocensus data

Figure 3-5: Population size of three caribou herds in Arctic Alaska, 1977-2017

Figure 3-6: Visual Resources Photo

Figure 3-7: Visual Resources Photo 2

Appendix B
Collaboration and Coordination

TABLE OF CONTENTS

Section Page

Appendix B. Collaboration and Coordination

B.1 List of Preparers

Name	Role/Responsibility
BLM Interdisciplinary Team	
Nicole Hayes	Project Manager
Cathy Hillis	GIS
Cindy Hamfler	GIS
Erin Julianus	Section 810 Hearings; Subsistence Uses and Resources
Scott Guyer	Climate and Meteorology; Soil Resources; Vegetation; Wetlands
Alan Peck	Air Quality; Water Resources
Steve Masterman (DNR)	Physiography
Paul Decker (DNR)	Geology and Minerals
Rob Brumbaugh	Petroleum Resources
Jessie Chmielowski	Petroleum Resources
Brent Breithaupt	Paleontological Resources
Joe Galluzzi	Sand and Gravel Resources
Richard Kemnitz	Water Resources
Mike McCrum	Solid and Hazardous Waste
Melody Debenham	Solid and Hazardous Waste
Thomas St. Clair	Wildland Fire
Matt Whitman	Fish and Aquatic Species
Casey Burns	Birds; Terrestrial Mammals; Special Status Species (includes Marine Mammals)
Jack Winters (SOA)	Terrestrial Mammals
Craig Perham (BOEM) – T&E Species	Special Status Species (includes Marine Mammals)
Donna Wixon	Land Ownership and Uses
Bob King	Cultural Resources
Joe Keeney	Cultural Resources
Randy Goodwin	Recreation; Special Designations (includes Wild and Scenic Rivers, Wilderness Characteristics, and Wilderness); Visual Resources; Transportation
Tom Bickauskus	Recreation; Special Designations (includes Wild and Scenic Rivers, Wilderness Characteristics, and Wilderness)
Stewart Allen	Economy
James Lima (BOEM)	Sociocultural Systems; Environmental Justice
Sara Longan	Public Health and Safety
EMPSi – Environmental Management and Planning Solutions, Inc.	
Chad Ricklefs, AICP	Project Manager
Amy Lewis	Assistant Project Manager; Public Involvement Lead
David Batts	Principal-in-Charge
Marcia Rickey, GISP	GIS Lead
Jenna Jonker	GIS
Francis Craig	GIS
Angie Adams	Special Designations (includes Wild and Scenic Rivers, Wilderness Characteristics, and Wilderness) Lead
Zoe Ghali	Social Systems Lead; Wildland Fire; Subsistence Uses and Resources; Economy; Sociocultural Systems; Environmental Justice
Katie Patterson, JD	Non-renewable Resources Lead; Petroleum Resources Lead; Physiography; Geology and Minerals; Sand and Gravel Resources; Solid and Hazardous Waste

Name	Role/Responsibility
Sean Cottle	CARA / Comment Analysis Lead; Special Designations (includes Wild and Scenic Rivers, Wilderness Characteristics, and Wilderness) Lead
Sarah Crump	Decision File / Administrative Record Lead; ePlanning Lead
Kate Krebs	Facilitator
Amy Cordle	Air Quality Lead; Climate and Meteorology; Noise Lead
Kevin Doyle	Paleontological Resources; Cultural Resources
Derek Holmgren	Soil Resources; Water Resources; Visual Resources Lead; Public Health and Safety
Meredith Zaccherio	Vegetation; Wetlands
Dan Morta	Wildland Fire Lead
Lindsay Chipman, PhD	Fish and Aquatic Species
Kevin Rice	Birds; Terrestrial Mammals; Special Status Species (includes Marine Mammals)
Peter Gower, AICP, CEP	Land Ownership Uses Lead; Recreation Lead; Transportation Lead
Matt Smith	Public Health and Safety Lead
Randy Varney	Technical Editing
Cindy Schad	Word Processing / 508 Compliance
ABR, Inc.	
Robert Burgess	Renewable Resources Lead
Wendy Davis	Vegetation Lead; Wetlands Lead
Terry Schick	Vegetation Lead; Wetlands Lead
John Seigle	Fish and Aquatic Species Lead
Adrian Gall	Birds Lead; Special Status Species (includes Marine Mammals)
Alexander Prichard	Terrestrial Mammals Lead; Special Status Species (includes Marine Mammals) Lead
Brian Lawhead	Terrestrial Mammals Lead; Special Status Species (includes Marine Mammals) Lead
DOWL	
Keri Nutter	Soil Resources Lead; Sand and Gravel Resources Lead
Adam Morrill	Solid and Hazardous Waste Lead
Leyla Arsan	Fish and Aquatic Species
HDR, Inc.	
Edward Liebsch	Climate and Meteorology Lead
Patricia Terhaar, PG	Physiography Lead; Geology and Minerals Lead
Anna Kohl	Paleontological Resources Lead
Jon Zufelt, PhD, PE	Water Resources Lead
Joe Miller	Water Resources
Northern Economics	
Leah Cuyno, PhD	Economy Lead
Michael Fisher, PMP	Economy
Patrick Burden	Economy
Michael Downs, PhD	Environmental Justice Lead
Stephen R. Braund & Associates (SRB&A)	
Stephen Braund	Section 810 Hearings: Cultural Resources Lead; Subsistence Uses and Resources Lead; Sociocultural Systems Lead
Paul Lawrence	Section 810 Hearings; Cultural Resources Lead; Subsistence Uses and Resources Lead; Sociocultural Systems Lead
Elizabeth Sears	Section 810 Hearings; Subsistence Uses and Resources Lead; Sociocultural Systems Lead
Jake Anders	Cultural Resources Lead

B.2 GOVERNMENT-TO-GOVERNMENT CONSULTATION

Location	Date	Tribal Government
Arctic Village	May 23, 2018	Arctic Village Council and Native Village of Venetie
Venetie	June 11, 2018	Native Village of Venetie, Venetie Village Council, Arctic Village Council
Kaktovik	June 13, 2018	Native Village of Kaktovik

B.3 ANCSA CORPORATION CONSULTATION

Corporation	Date
Arctic Slope Regional Corporation	April 25, May 18, and June 16, 2018
Doyon Limited	July 6, 2018
Kaktovik Inupiat Corporation	June 13, 2018

Appendix C

Section 810 Analysis

(to be included in the next iteration)

Appendix D

Laws, Regulations, and Permits

TABLE OF CONTENTS

Chapter Page

Appendix D. Laws, Regulations, and Permits

Requirements of federal, state, and local laws and regulations associated with future development activities in the Coastal Plain are provided below.

D.1 TREATIES

D.1.1 Agreement on the Conservation of Polar Bears

This is an agreement between the governments of Canada, Denmark, Norway, the former USSR, and the United States. It recognizes the responsibilities of circumpolar countries for coordinating actions to protect polar bears. The agreement prohibits hunting, killing, and capturing polar bears except for bona fide scientific and conservation purposes, preventing serious disturbance to the management of other living resources, and by local people under traditional rights. This multilateral agreement also commits each associated country to sound conservation practices by protecting the ecosystem of polar bears, with special attention to denning areas, feeding sites, and migration corridors based on best available science through coordinated research. The agreement was signed by the United States on November 15, 1973, in Oslo, Norway; ratified on September 30, 1976; and entered into force in this country on November 1, 1976.

D.1.2 International Porcupine Caribou Herd Agreement

In 1987, the US and Canadian governments signed the "Agreement between the Government of the United States of America and the Government of Canada on the Conservation of the Porcupine Caribou Herd." This bilateral agreement recognizes that the Porcupine caribou herd regularly migrates across the international boundary between Canada and the United States and that the herd should be conserved according to ecological principles emphasizing the importance of conserving habitat, including calving, post-calving, migration, wintering, and insect relief habitat. The main objectives of the agreement are to conserve the herd and its habitat through international cooperation and coordination so that the risk of irreversible damage or long-term adverse effects, including cumulative effects, as a result of use of caribou or their habitat is minimized, and to ensure opportunities for customary and traditional uses of the Porcupine caribou herd. The agreement set up the International Porcupine Caribou Board, composed of delegated representatives from both countries that give advice and recommendations to the countries on the conservation and management of the herd. The International Porcupine Caribou Board, in turn, set up the Porcupine Caribou Technical Committee, composed of biologists from each country to advise them in their recommendations. This agreement was signed by the United States on July 17, 1987, in Ottawa, Canada, and entered into force in this country upon signing.

D.2 LAWS AND REGULATIONS

D.2.1 US Bureau of Land Management (BLM)

- The National Environmental Policy Act of 1969 (NEPA) sets out policy and provides the means by which the federal government, including the BLM and the federal cooperating agencies, examines major federal actions that may have significant impacts on the environment, such as the authorization of oil and gas development contemplated in this environmental impact statement (EIS) (42 United State Code [USC] Section 4231 et seq.).

- Title VIII of Alaska National Interest Lands Conservation Act (ANILCA) establishes procedures for federal land management agencies to evaluate impacts on subsistence uses and needs and means to reduce or eliminate such impacts on federally managed lands (16 USC Section 3120).
- The Mineral Leasing Act of 1920 (30 USC Section 185, 43 Code of Federal Regulations (CFR) Part 2880), provides the BLM with the authority to issue right-of-way grants for oil and natural gas pipelines and related facilities (not authorized by appropriate leases).

D.2.2 The US Army Corps of Engineers

The US Army Corps of Engineers has the authority to issue or deny permits for placement of dredge or fill material in the waters of the US, including wetlands and for work and/or structures in, on, over, or under navigable waters of the US. These U.S. Army Corps of Engineers authorities are set forth as follows.

- Under Section 404 of the Clean Water Act of 1972 (33 USC Section 1251 et seq.), the US Army Corps of Engineers regulates placement of dredge and fill material in waters of the US, including wetlands.
- Under Section 10 of the Rivers and Harbors Act (33 USC Section 401), the US Army Corps of Engineers has regulatory authority for work and structures performed in, on, over, or under navigable waters of the US.

D.2.3 The US Environmental Protection Agency (EPA)

The EPA authority to regulate oil and gas development is contained in the Clean Water Act of 1972 (CWA) (33 USC Section 1251 et seq.), Clean Air Act of 1963 (CAA) (42 USC Section 7401 et seq.), and the Safe Drinking Water Act of 1974 (42 USC Section 300f et seq.). These authorities follow.

- Under Section 402 of the CWA (33 USC Section 1251 et seq.), the EPA has delegated authority to the State of Alaska to issue permits for facilities operating within state jurisdiction of permits issued for the discharge of pollutants from a point source into waters of the US for facilities, including oil and gas. Point-source discharges that require an Alaska Pollutant Discharge Elimination System permit include, but are not limited to, sanitary and domestic wastewater, gravel pit and construction dewatering, and hydrostatic test water, storm water discharges, etc. (40 CFR 122).
- In accordance with Section 404 of the CWA (33 USC Section 1251 et seq.), the EPA reviews and comments on US Army Corps of Engineers Section 404 permit applications for compliance with the Section 404(b)(1) guidelines and other statutes and authorities within its jurisdiction (40 CFR 230).
- Under the Safe Drinking Water Act (42 USC Section 300f et seq.), the EPA's responsibilities include the management of the Underground Injection Control program and the direct implementation of Class I and Class V injection wells in Alaska. These wells cover injection of non-hazardous and hazardous waste through a permitting process for fluids that are recovered from down hole, as well as municipal waste, stormwater, and other fluids that did not come up from down hole (40 CFR 124A, 40 CFR 144, 40 CFR 146). The EPA oversees the Class II program delegated to the State of Alaska that is managed by the Alaska Oil and Gas Conservation Commission, which includes Class II enhanced oil recovery, storage, and disposal

wells that may receive non-hazardous produced fluids originating from down hole, including muds and cuttings (40 CFR 147).

- Under Sections 165 and 502 of the Clean Air Act (42 USC Section 7401 et seq.), the State of Alaska is delegated authority to issue air quality permits for facilities operating within state jurisdiction for the Title V operating permit (40 CFR 70) and the "prevention of significant deterioration" permit (40 CFR 52.21) to address air pollution emissions. The EPA maintains oversight authority of the State's program.
- Under Section 311 of the Federal Water Pollution Control Act of 1972, as amended (CWA, 33 USC Section 1321, 40 CFR Part 112), the EPA requires a "spill prevention containment and countermeasure plan" for storage of over 660 gallons of fuel in a single container or over 1,320 gallons in aggregate aboveground tanks.
- Under the CWA as amended (Oil Pollution Act; 33 USC Chapter 40; FRP Rule; 40 CFR Part 112, Subpart D, Section 112.20–112.21) the EPA requires a "facility response plan" to identify and ensure the availability of sufficient response resources for the worst case discharge of oil to the maximum extent practicable, "…generally for facilities that transfer over water to or from vessels, and maintaining a capacity greater than 42,000 gallons, or any facility with a capacity of over one million gallons."
- 40 CFR parts 1500–1508 and Section 309 of the CAA (42 USC Section 7609): requires a review and evaluation of the draft and final EIS for compliance with Council on Environmental Quality guidelines.

D.2.4 The US Fish and Wildlife Service (USFWS)

The decisions ascribed to the USFWS on its responsibilities to enforce the Endangered Species Act of 1973 (ESA) (including marine mammal and bird species subject to the Act). Specifically, the USFWS provides consultation (recommendation) as required under Section 7 of the Act. The USFWS also provides consultation regarding impacts to fish and wildlife resources under the Fish and Wildlife Coordination Act.

D.2.5 The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management's Office of Environmental Programs conducts NEPA analyses and gathers compliance documents for each major stage of energy development planning related to offshore oil and gas development. Bureau of Ocean Energy Management will not issue permits associated with this EIS; however, the Bureau provided subject matter expertise in the drafting and review of this NEPA document. The Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska, established under Executive Order (EO) 13580, adopted the concept of "integrated arctic management" to ensure that decisions on development and conservation made in the Arctic are driven by science, stakeholder engagement, and government coordination.

D.2.6 Executive Orders

In addition to the statutory authorities described above, a number of EOs apply to all federal agencies. These include EOs 11988 (Floodplain Management), 11990 (Protection of Wetlands), 12898 (Environmental Justice), 13075 (Tribal Consultation), and 13112 (Invasive Species Control).

D.2.7 North Slope Borough

The North Slope Borough, as a Home Rule Borough, issues development permits and other authorizations for oil and gas activities under the terms of its ordinances (North Slope Borough Municipal Code Title 19).

D.2.8 State of Alaska

The State has responsibility for issuance of several permits. Alaska's Department of Natural Resources issues temporary water use and water rights permits, permits for cultural resource surveys, cultural resource concurrences, and other authorizations for activities associated with oil and gas development. The Alaska Department of Fish and Game issues fish habitat permits. Under the state implementation plan, the Alaska Department of Environmental Conservation issues prevention of significant deterioration and other air quality permits. The Alaska Department of Environmental Conservation is responsible for issuing several permits and plan approvals for oil and gas exploration and development activities, including the storage and transport of oil and cleanup of oil spills. The Alaska Oil and Gas Conservation Commission is responsible for issuing drilling permits and for production, injection, and disposal plan approvals for exploration and development activities in the State of Alaska. Additional state authorities are presented below.

Alaska Department of Natural Resources

- Issues rights-of-way and land use permits for use of state land, ice road construction on state land, and state freshwater bodies under Alaska Statute (AS) 38.05.850.
- Issues a "temporary water use and water rights" permit under AS 46.15 for water use necessary for construction and operations.
- Issues "Alaska cultural resource permits" for cultural resource surveys under the Alaska Historic Preservation Act (AS 41.35.080).
- Issues "cultural resources concurrences" for development on state land (but not federally managed land) that may affect historic or archaeological sites under the National Historic Preservation Act of 1966, as amended (16 USC Section 470 et seq.), and the Alaska Historic Preservation Act (AS 41.35.010 through .240).

Alaska Department of Environmental Conservation

- Issues an Alaska Pollutant Discharge Elimination System "wastewater discharge permit" and "mixing zone approval" for wastewater disposal into all state waters under a transfer of authority from the EPA National Pollutant Discharge Elimination System (NPDES) Program under Section 402, Federal Water Pollution Control Act of 1972, as amended CWA, 33 USC Section 1342); AS 46.03.020, .100, .110, .120, and .710; 18 Alaska Administrative Code (AAC) chapters 15, and 70, and; Section 72.500.
- Issues a certificate of reasonable assurance/NPDES Program and mixing zone approval for wastewater disposal into all state waters under Section 402, Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC Section 1342); AS 46.03.020, .100, .110, .120, and .710; 18 AAC chapters, 10, 15, and 70, and; Section 72.500.
- Issues a Class I well wastewater disposal permit for underground injection of non-domestic wastewater under AS 46.03.020, .050, and .100.

- Reviews and approves all public water systems including plan review, monitoring program, and operator certification under AS 46.03.020, .050, .070, and .720, 18 AAC Section 80.005.
- Approves domestic wastewater collection, treatment, and disposal plans for domestic wastewaters (18 AAC Chapter 72).
- Approves financial responsibility for cleanup of oil spills (18 AAC Chapter 75).
- Reviews and approves the "oil discharge prevention and contingency plan" under the Oil Pollution Act of 1990 (OPA) and the "certificate of financial responsibility" for storage or transport of oil under AS 46.04.030 and 18 AAC Chapter 75. The State review applies to oil exploration and production facilities, crude oil pipelines, oil terminals, tank vessels and barges, and certain non-tank vessels.
- Issues a Title V operating permit and a prevention of significant deterioration permit under CAA Amendments (Title V) for air pollutant emissions from construction and operation activities (18 AAC Chapter 50).
- Issues solid waste disposal permit for state lands under AS 46.03.010, 020, 100, and 110; AS 46.06.080; 18 AAC Section 60.005; and 200.
- Reviews and approves solid waste processing and temporary storage facilities plan for handling and temporary storage of solid waste on federal and state lands under AS 46.03.005, 010, and 020; and 18 AAC Section 60.430.
- Approves the siting of hazardous waste management facilities.

Alaska Department of Fish and Game

- Issues "fish habitat permits" under AS 16.05.871 and AS 16.05.841 for activities within streams used by fish that the agency determines could represent impediments to fish passage, or for travel in, excavation of, or culverting of anadromous fish streams.
- AS16.05.841–Fishway Act deals exclusively with fish passage; applies to streams with documented resident fish use and without documented use by anadromous fish.
- AS16.05.871–Anadromous Fish Act applies to streams specified in the Anadromous Waters Catalog as important for the spawning, rearing or migration of anadromous fishes; much broader authority and extends to anadromous fish habitat.
- Evaluates potential impacts to fish, wildlife and fish and wildlife users, and presenting any related recommendations to state land managers (Alaska Department of Natural Resource) or, via the Fish and Wildlife Coordination Act, to federal permitting agencies.

Alaska Oil and Gas Conservation Commission

- Issues a "permit to drill" under 20 AAC Section 25.05.
- Issues approval for annular disposal of drilling waste (20 AAC Section 25.080).
- Authorizes "plugging, abandonment, and location clearance" (20 AAC Section 25.105 through 25.172).
- Authorizes "production practices" (20 AAC Section 25.200–25.245).
- Authorizes "Class II waste disposal and storage" (20 AAC Section 25.252).
- Approves "workover operations" (20 AAC Section 25.280).

- Reports (20 AAC Section 25.300–25.320).
- Authorizes "enhanced recovery operations" under 20 AAC Section 25.402–460.

D.3 FEDERAL, STATE, AND LOCAL PERMITS AND/OR APPROVALS FOR OIL AND GAS EXPLORATION, DEVELOPMENT, AND PRODUCTION ACTIVITIES

The following table summarizes permits and other requirements that must be met before oil and gas exploration or development activities may occur. Some obligations would be placed directly on the applicant. Others would be required of federal agencies prior to granting authorizations to oil and gas companies.

Regulatory Agency	Permit/Approval Actions/Requirements
Federal	
National Oceanic and Atmospheric Administration (NOAA) Fisheries Service (formerly National Marine Fisheries Service [NMFS])	• Provides consultation under the ESA, Section 7(a)(2) regarding effects to threatened or endangered species. • Provides consultation under the Magnuson-Stevens Fishery Management and Conservation Act for effects on Essential Fish Habitat. • Provides consultation under the Fish and Wildlife Coordination Act regarding effects on fish and wildlife resources. • Provides consultation under the Marine Mammal Protection Act regarding effects on marine mammals. • Issues Incidental Harassment Authorization under the Marine Mammal Protection Act for incidental takes of protected marine mammals (bowhead whales and ringed seals).
US Army Corps of Engineers	• Issues a section 404 permit under the Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC § 1344) for discharge of dredged and fill material into waters of the US, including wetlands. • Issues a section 10 permit under the Rivers and Harbors Appropriations Act of 1899 (33 USC § 403) for structures or work in, of affecting, navigable waters of the US. • Issues a section 103 Ocean Dumping permit under section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (33 USC § 1413) for transport of dredged material for ocean disposal.
US Bureau of Land Management (BLM)	• Reviews and approves Applications for Permit to Drill (including drilling plans and surface-use plans of operations) and Subsequent Well Operations as prescribed in 43 CFR part 3160, under authority of other Federal laws, for development and production of Federal leases. • Approves lease administration requirements including Unit Agreements and Plans of Development, Communitization Agreements, and Participating Area Determinations, as described in 43 CFR parts 3130 and 3180 and other Federal laws, for exploration and development of oil and gas leases. • Issues geophysical permits to conduct seismic activities as described in 43 CFR part 3150, under authority of the Mineral Leasing Act of 1920, ANILCA (16 USC §§ 3101 et seq.), and Department of the Interior Appropriations Act, Fiscal Year 1981. • Issues rights-of-way grants and temporary use permits for the construction, operation, and maintenance of pipeline, production, and related facilities. • Delegates authority to Alaska Department of Environmental Conservation (ADEC) for review and approval of Oil Discharge Prevention and Contingency Plans and Certification of Financial Responsibility for accidental oil discharge into navigable waters under section 1016 of the Oil Pollution Act of 1990 (OPA90; 33 USC § 2716), and Section 311(j)(5) of

Regulatory Agency	Permit/Approval Actions/Requirements
	the Federal Water Pollution Control Act (33 USC § 1321(j)(5); 30 CFR part 254). • Reviews and approves temporary use permits. • Issues material sale permits. • Threatened and endangered species formal consultation biological assessment; ESA determination for National Marine Fisheries Service-managed species. • Essential fish habitat assessment. • ANILCA 810 evaluation and findings. • Compliance with Section 106 of the National Historic Preservation Act. • Off-lease disposal of produced water. • EO 13075 Tribal consultation.
US Environmental Protection Agency (EPA)	• Issues an Underground Injection Control Class I Industrial Well permit under the Safe Drinking Water Act (42 USC §§ 300f et seq.; 40 CFR parts 144 and 146) for underground injection of Class I (industrial) waste materials. • Requires a Spill Prevention Containment and Countermeasure (SPCC) Plan under section 311 of the Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC § 1321;40 CFR part 112) for storage of over 660 gallons of fuel in a single container or over 1,320 gallons in aggregate in tanks above ground. • Requires a Facility Response Plan (FRP) under the CWA as amended (Oil Pollution Act; 33 USC 40) to identify and ensure the availability of sufficient response resources to respond to the worst-case discharge of oil to the maximum extent practicable. • Conducts a review and evaluation of the Draft and Final EIS for compliance with Council on Environmental Quality guidelines (40 CFR parts 1500-1508) and section 309 of the CAA (42 USC § 7609). • Authority delegated to ADEC to issue air quality permits for facilities operating within state jurisdiction, including a Title V operating permit and a Prevention of Significant Deterioration (PSD) permit under the CAA, as amended (42 USC §§ 7401 et seq.), to address air pollutant emissions.
US Fish and Wildlife Service (USFWS)	• Provides consultation under the ESA, section 7(a)(2) regarding effects to threatened or endangered species. • Provides consultation under the Fish and Wildlife Coordination Act regarding effects to fish and wildlife resources. • Issues a Letter of Authorization under the Marine Mammal Protection Act for incidental takes of marine mammals.
State	
Alaska Department of Environmental Conservation (ADEC)	• Issues a Certificate of Reasonable Assurance for discharge of dredged and fill material into US waters under section 401, Federal Water Pollution Control Act of 1972, as amended in 1977 (CWA; 33 USC § 1341); AS 46.03.020; 18 AAC chapters 15, 70, and 72. • Issues a Certificate of Reasonable Assurance/NPDES and Mixing Zone Approval for wastewater disposal into all state waters under section 402, Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC § 1342); AS 46.03.020, .100, .110, .120, and .710; 18 AAC chapters, 10, 15, and 70, and; § 72.500. • Issues a Class I well wastewater disposal permit for underground injection of non-domestic wastewater under AS 46.03.020, .050, and .100. • Reviews and approves all public water systems including plan review, monitoring program, and operator certification under AS 46.03.020, .050, .070, and .720, 18 AAC § 80.005.

Regulatory Agency	Permit/Approval Actions/Requirements
	• Approves domestic wastewater collection, treatment, and disposal plans for domestic wastewaters (18 AAC chapter 72). • Approves financial responsibility for cleanup of oil spills (18 AAC chapter 75). • Reviews and approves the Oil Discharge Prevention and Contingency Plan and the Certificate of Financial Responsibility for storage or transport of oil under AS 46.04.030 and 18 AAC chapter 75. The State review applies to oil exploration and production facilities, crude oil pipelines, oil terminals, tank vessels and barges, and certain non-tank vessels. • Issues a Title V Operating Permit and a PSD permit under CAA Amendments (Title V) for air pollutant emissions from construction and operation activities (18 AAC chapter 50). • Issues NPDES permits under section 402, Federal Water Pollution Control Act of 1972, as amended (CWA; 33 USC § 1342) for discharges into waters of the US. • Issues solid waste disposal permit for state lands under AS 46.03.010, 020, 100, and 110; AS 46.06.080; 18 AAC § 60.005; and 200. • Reviews and approves solid waste processing and temporary storage facilities plan for handling and temporary storage of solid waste on federal and state lands under AS 46.03.005, 010, and 020; and 18 AAC § 60.430. • Approves the siting of hazardous waste management facilities. • Issues air quality permit.
Alaska Department of Fish and Game (ADFG)	• Issues Fish Habitat Permits under AS 41.14.840 and AS 41.14.870 for activities within streams used by fish that agency determines could represent impediments to fish passage, or for travel in, excavation of, or culverting of anadromous fish streams. • Issues public safety permit for non-lethal hazing of wild animals that are creating a nuisance or a threat to public safety.
Alaska Department of Natural Resources (ADNR)	• Issues a Material Sales Contract for mining and purchase of gravel from state lands under AS 38.05.850; and 11 AAC §§ 71.070 and .075. • Issues Rights-of-Way (ROW) and Land Use permits for use of state land, ice road construction on state land, and state freshwater bodies under AS 38.05.850. • Issues a Temporary Water Use and Water Rights permit under AS 46.15 for water use necessary for construction and operations. • Issues pipeline ROW leases for pipeline construction and operation across state lands under AS 38.35.020. • Issues a Cultural Resources Concurrence for developments that may affect historic or archaeological sites under the National Historic Preservation Act of 1966, as amended (16 USC §§ 470 et seq.), Alaska Historic Preservation Act (AS 41.35.010 through .240).
Alaska Oil and Gas Conservation Commission (AOGCC)	• Issues a Permit to Drill under 20 AAC § 25.05. • Issues approval for annular disposal of drilling waste (20 AAC § 25.080). • Authorizes Plugging, Abandonment, and Location Clearance (20 AAC § 25.105 through 25.172). • Authorizes Production Practices (20 AAC §§ 25.200 through 25.245). • Authorizes Class II Waste Disposal and Storage (20 § AAC 25.252). • Approves Workover Operations (20 § AAC 25.280). • Reports (20 AAC §§ 25.300 through 25.320). • Authorizes Enhanced Recovery Operations under 20 AAC §§ 25.402-460.
Office of Public Safety	• Fire marshal approval.

Regulatory Agency	Permit/Approval Actions/Requirements
	Local
North Slope Borough (NSB)	• Issues Development Permits for oil and gas projects under NSB Code of Ordinance Title 19. • Iñupiat History, Language, and Culture Division–traditional land use inventory clearance.
Kaktovik Iñupiat Corporation	• Land use authorization for facilities constructed on Iñupiat Corporation land.
Native Village of Kaktovik	• EO 13075 Tribal consultation.
Native Village of Venetie Tribal Government	• EO 13075 Tribal consultation.
Venetie Village Council	• EO 13075 Tribal consultation.
Arctic Village Council	• EO 13075 Tribal consultation.

Appendix E

Reasonable Foreseeable Development Scenario for Oil and Gas Resources in the Public Law 115-97 Coastal Plain, Alaska

TABLE OF CONTENTS

Section Page

List of Acronyms

3D	three-dimensional
Arctic Refuge	Arctic National Wildlife Refuge
BBO	billion barrels of oil
Coastal Plain	Public Law 115-97 Coastal Plain
CPF	central processing facility
EIS	Environmental Impact Statement
EIA	Energy Information Administration
Leasing EIS	Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement
NEPA	National Environmental Policy Act
NPR-A	National Petroleum Reserve Alaska
RFD	Reasonably Foreseeable Development
ROD	Record of Decision
TAPS	Trans-Alaska Pipeline System
TCF	trillion cubic feet
USGS	United States Geological Survey
US	United States
VSM	Vertical support members

Appendix E. Reasonable Foreseeable Development Scenario for Oil and Gas Resources in the Public Law 115-97 Coastal Plain, Alaska

E.1 Summary

This Reasonably Foreseeable Development (RFD) scenario represents a hypothetical projection of oil and gas exploration, development, production, and abandonment activity in the Public Law 115-97 Coastal Plain (Coastal Plain). Estimating the level of future oil and gas activity in this area is difficult at best. Timing and location of future commercially viable discoveries cannot be more accurately projected until exploration of these reserves occurs. The baseline scenario projects development under standard lease terms and encompasses restrictions in the enacting legislation. Scenarios by alternative incorporate the management considered in the Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement (Leasing EIS).

The Coastal Plain encompasses approximately 1.6 million acres of federal land in the northernmost end of the Arctic National Wildlife Refuge (Arctic Refuge). Alaska Native allotment lands and Alaska Native lands that are patented or interim conveyed are excluded from the project area.

Very little oil and gas exploration has occurred in this area, and there are no known plays at this point. The United States Geological Survey (USGS) has estimated there is a 95-percent probability that the 1002 Area of the Arctic Refuge (which is similar in size and boundary, but not identical to the current Coastal Plain) contains a technically recoverable volume of least 5.92 billion barrels of oil (BBO), and a 5-percent probability that the technically recoverable volume of oil could be 15.16 BBO. The mean estimate of technically recoverable oil for the 1002 Area of the Arctic Refuge is 10.35 BBO. Of this, 80 to 90 percent was estimated to be economically recoverable at $42 per barrel (2009 dollars) (Attanasi and Freeman 2009). Alaska North Slope crude is currently priced around $65 per barrel (ycharts.com 2018), and the US Energy Information Administration (EIA) projects that crude oil prices will continue to rise in the next 20 years (EIA 2018). More recent estimates published by the EIA put mean oil production in the Coastal Plain at 3.4 BBO produced by 2050 (Van Wagner 2018).

Gas reserves are estimated at 7.04 trillion cubic feet (TCF; Attanasi 2005) however no gas production is anticipated in the project area in the next 20 years. Proposed plans to build gas pipelines connecting the North Slope to potential markets would to first connect to better understood and established fields before connections to the Coastal Plain would be considered. There are estimated to be 225 million barrels of natural gas liquids in the project area; these would not be targeted but could be produced as a byproduct of oil production in some formations.

E.2 Introduction

This RFD provides an estimate of the levels of petroleum-related activities and associated surface disturbances under an unconstrained baseline scenario and discusses how those activities may vary for

each alternative. It also presents a description of the geology and the oil and gas resource estimates in the Coastal Plain and identifies the assumptions used to develop projections. The petroleum-related activities described in this RFD are useful only in a general sense because the timing and location of future commercial-sized discoveries cannot be accurately predicted until exploration drilling occurs. However, it is reasonable to expect that new technologies and designs developed in the future will augment exploration and development efforts and will enhance the safety and efficiency of operations while minimizing the effects of oil activity on the environment. An RFD scenario represents the most likely projection (scenario) of oil exploration, development, production, and abandonment activity. In an effort to minimize the chance that the resultant impact analysis will understate potential impacts, the scenarios are intended to represent optimistic high-production, successful discovery and development scenarios in a situation of favorable market prices.

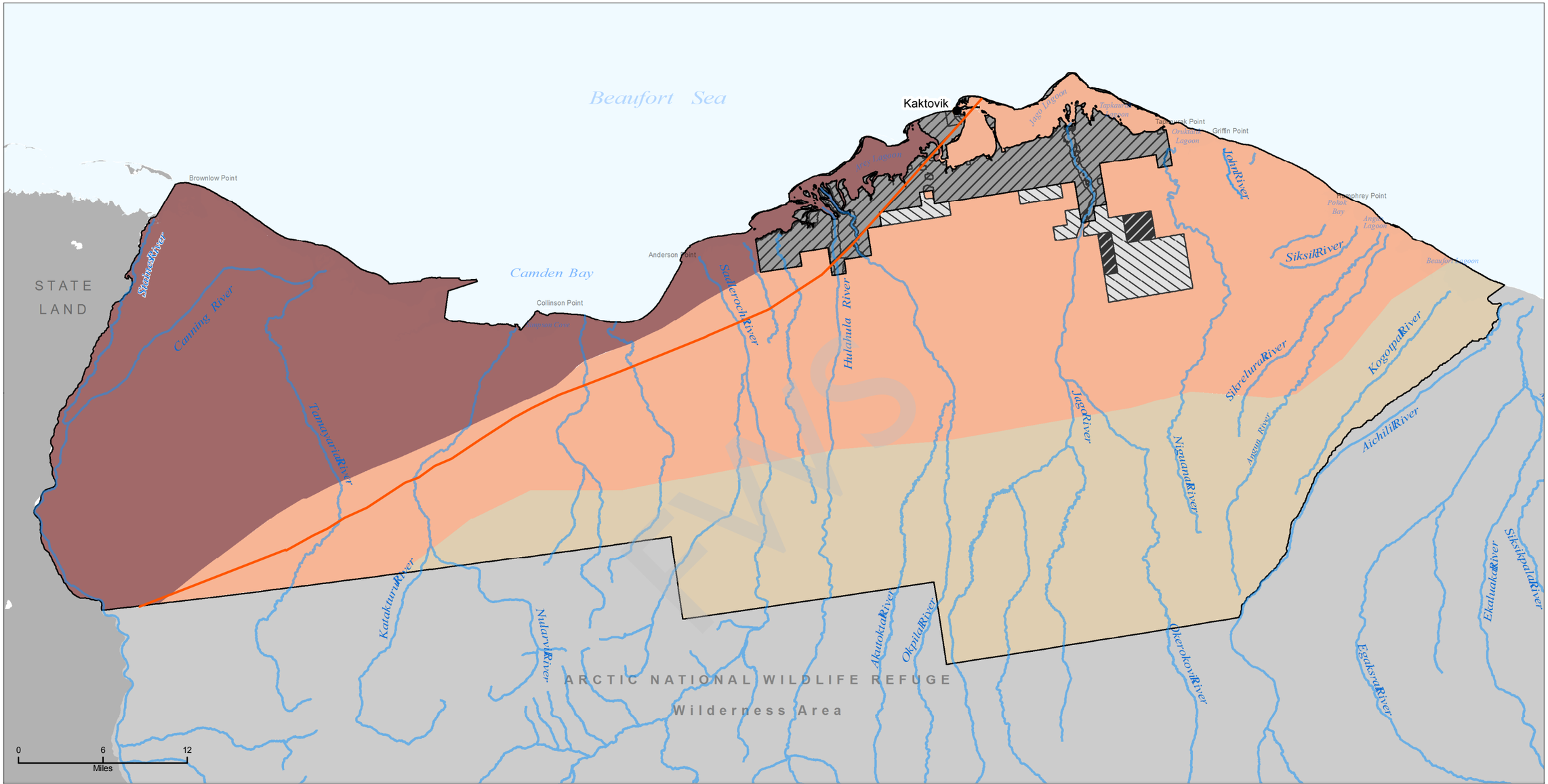
Current state-of-the-art oil technologies, methods, and designs are used to project scenarios for future petroleum development. Petroleum-related activities include such major undertakings as conducting seismic operations; constructing ice roads and snow trails for transporting equipment and supplies for winter drilling of exploration wells; drilling exploration and delineation wells; constructing gravel pads, roads connecting production pads to main facilities, and landing strips; drilling production and service wells; installing pipelines; and constructing oil and gas processing facilities. Impacts caused by the extraction of resources for energy purposes cannot be assessed without estimating future activity. A fundamental assumption of these scenarios is that the level of future activities is directly related to the petroleum resource potential made available for leasing and development. However, industry's interest in exploring for new reserves is influenced by profit motives, where opportunities for new production in northern Alaska must compete with projects elsewhere. Consequently, future development activities and associated impacts are influenced by several factors, including the perceptions of economic potential of the area, the areas available for leasing, industry's ability to identify prospects to drill, and the competitive interest in exploring for new fields.

Natural gas is not anticipated to be produced in the Coastal Plain in the foreseeable future because there is no transportation system to move gas to market. Comingled gas produced with oil would be separated and reinjected into the formation as part of the reservoir stimulation process.

E.3 Description of Geology

A thin layer of surficial deposits covers the bedrock geology in most places within the Coastal Plain. Therefore, information and understanding of the bedrock geology has been obtained primarily from geophysical remote sensing, observations in the mountains south of the area, and wells drilled west and north of the area (Bird 1999). As a result, localized geology is not as well understood as it is in most oil fields, where data collected from wells are used to inform geologic understanding.

The geology of the Coastal Plain is split into undeformed and deformed areas demarked by the Marsh Creek anticline, which runs northeast-southwest across the Coastal Plain (see **Map E-1**, Hydrocarbon Potential). Northwest of the Marsh Creek anticline, the undeformed area rocks are generally horizontal. Southeast of the anticline, the deformed area rocks show significantly more folding and faulting. Rocks with petroleum potential in the Coastal Plain area are mostly younger than Devonian and are divided into the Ellesmerian sequence of Mississippian to Early Cretaceous age, and the Brookian sequence of Cretaceous to Cenozoic age (Bird and Magoon 1987). The Ellesmerian sequence is up to 1km thick,



Marsh Creek anticline

Hydrocarbon potential
- High
- Medium
- Low

Public Law 115-97 Coastal Plain

Outside BLM's oil and gas leasing authority:
- Excluded from Public Law 115-97 Coastal Plain
- Native-selected
- Interim conveyed land

Data Source: BLM GIS 2018
Print Date: 08/07/2018

primarily composed of equal amounts of carbonate and clastic rocks. The Brookian sequence consists of up to 7km of marine and nonmarine siliciclastic deposits originating from the ancestral Brooks Range. The most likely petroleum reservoir rocks beneath the Coastal Plain are intrabasement carbonate rocks, Ellesmerian sandstone similar to that of the Kemik Sandstone or Thomson sand of local usage, and Brookian turbidite sandstone in the Canning Formation or deltaic sandstone in the Sagavanirktok and Jago River Formations. The timing of hydrocarbon generation relative to the formation of traps is judged to be favorable for the retention of oil in the Coastal Plain area. Structural traps are believed to have formed before, during, and after oil generation and migration (Bird and Magoon 1987).

E.3.1 Undeformed Area

Approximately 80 percent of petroleum resources are estimated to be in the undeformed western portion of the 1002 Area (USGS 1998). The identified potential plays in this area, in order of greatest to least potential, include the Topset play, Turbidite play, Wedge Play, Thompson play, Undeformed Franklinian play, and Kemik play. Total reserves from these plays are estimated to be 6.420 BBO (Attanasi 2005). **Table E-1**, below, gives estimates of recoverable petroleum resources in the undeformed area. Development is expected to begin in the Topset play which is estimated to contain over half the recoverable oil reserves in the Coastal Plain. Initial interest would be in test wells drilled in areas where seismic data reveals traps or where the formation is particularly thick. Areas where multiple plays overlap are also expected to receive early exploration and development interest.

Table E-1
Estimated Mean Undiscovered Petroleum Resources in the Undeformed 1002 Area

Play name	Oil (BBO)	Natural Gas Liquids (Billion barrels of liquid)
Topset	4.325	0.010
Turbidite	1.279	0.065
Wedge	0.438	0.005
Thompson	0.246	0.039
Kemik	0.047	0.010
Undeformed Franklinian	0.085	0.029
Total	**6.420**	**0.159**

Note: Totals are technically recoverable amounts.
Source: Attanasi 2005

E.3.1 Deformed Area

Potential plays in the deformed area, in order of greatest to least potential, include the Thin-Skinned Thrust belt play, Niguanak/Aurora play, Deformed Franklinian play, and Ellesmerian Thrust Belt play. Total reserves from these plays are estimated to be 1.267 BBO (Attanasi 2005). **Table E-2**, below, gives estimates of recoverable petroleum resources in the deformed area. Plays in the deformed are expected to be developed only in areas where seismic data and test wells indicate a very promising field.

Table E-2
Estimated Mean Undiscovered Petroleum Resources in the Deformed 1002 Area

Play name	Oil (BBO)	Natural Gas Liquids (Billion barrels of liquid)
Thin-Skinned Thrust Belt	1.038	0.017
Ellesmerian Thrust Belt	0.000	0.018
Deformed Franklinian	0.046	0.046
Niguanak/Aurora	0.183	0.016
Total	**1.267**	**0.096**

Note: Totals are technically recoverable amounts.
Source: Attanasi 2005

E.2 Past Oil Exploration Activity

Due to a prohibition on oil and gas leasing until the passage of the Tax Act of 2017, very little exploration has occurred in the Coastal Plain. A two-dimensional seismic survey was conducted by an industry group in the winters of 1984-1985 and 1985-1986 (DOI 1987). The data collected has contributed to every analysis of oil and gas potential in the Coastal Plain since. The data are currently being re-processed using modern techniques and equipment.

E.3 Oil Occurrence and Development Potential

Oil occurrence and development potential was developed based on the locations of the plays discussed above in *Description of Geology*. Areas where plays with larger estimated reserves are overlapping were considered as high occurrence potential, areas where only one or two plays with significant reserves were overlapping were considered moderate potential, and areas with only minor plays were considered low potential. The highest potential areas are in the western and northern part of the Coastal Plain. See **Map E-1**, Hydrocarbon Potential, above for a visual depiction of potential areas.

Since no infrastructure currently exists in the Coastal Plain, development is expected to follow oil occurrence potential very closely rather than trying to build off existing infrastructure as might occur in a field with existing development. However, the closest infrastructure outside the Coastal Plain is near

the northwest border of the area. This coincides with the area of highest occurrence potential. Moving further from the existing infrastructure near the northwest border of the Coastal Plain, areas would be increasingly less economical to reach. Therefore, development potential (which accounts for economic considerations in addition to resource occurrence) coincides with occurrence potential for the Coastal Plain.

E.4 METHODOLOGY AND ASSUMPTIONS FOR RFD SCENARIO PROJECTIONS

There are many uncertainties associated with projecting future petroleum exploration and development. These uncertainties include the amount and location of technically recoverable oil; the timing of oil field discoveries and associated development; the future prices of oil and gas, and, more to the point, the many exploration companies' individual assessment of future prices and other competitive calculations that play into corporate investment decisions; and the ability of industry to find petroleum to mobilize the requisite technology to exploit it.

To address these uncertainties, the BLM has made reasonable assumptions based on the previous two-dimensional seismic exploration of the Coastal Plain, the history of development in the National Petroleum Reserve-Alaska (NPR-A) and other North Slope developments, its own knowledge of the almost entirely unexplored petroleum endowment of the Coastal Plain and current industry practice, and professional judgment. In making these assumptions, the BLM has striven to minimize the chance that the resultant impact analysis will understate potential impacts. Therefore, the scenarios are intended to represent optimistic high-production, successful discovery and development scenarios in a situation of favorable market prices. The amount of infrastructure that would be necessary to develop the projected amount of oil is also estimated at upper, but reasonable, limits. For example, it is assumed that each satellite production pad would disturb approximately 12 acres and contain 30 wells (approximately 2.5 wells per acre), though the experience as ConocoPhillips develops newer well pads in the Colville River Unit (commonly referred to as Alpine) and the Greater Moose's Tooth Unit would suggest that on average, pad sizes for that many wells may be able be closer to 10 acres (approximately 3.3. wells per acre). However, the estimates account for advances in technology that have allowed development on the North Slope to become less impactful on the surrounding environment. For example, the older well pads in Alpine had a ratio of 1.6 to 2.2 wells per acre.

The time frame used for the RFD scenarios is the estimated minimum amount of time in which development of the Coastal Plain could reach the 2,000-acre disturbance cap. Because there are very little data on and no existing infrastructure in the Coastal Plain, there would be a lag time between the first lease sale and the beginning of production in the area. The activities that would occur and the estimated timing of those activities are further described in the *RFD Baseline Scenario*, below. The overall minimum time anticipated for all wells to be completed in the Coastal Plain under any scenario is approximately 50 years. Because it is unlikely that all projected wells would be producing at the same time, peak production from the Coastal Plain is anticipated at some point before 50 years, potentially as early as 20 years after the first lease sale. Once peak production is reached, production from a field is anticipated to continue for up to another 35 years, depending on resource production, market forces, and operator financial decisions. Therefore, it could be 85 years or more after the first lease sale before all facilities described in the scenarios are abandoned and reclaimed. However, just as development is expected to occur in phases, reclamation would occur in phases. The first field to be developed could be reclaimed long before the last field is abandoned.

Additional assumptions, some of which also tend to support an optimistic set of development scenarios, include:

- Multiple lease sales would be held, with the first sale within first year after the signing of the ROD
- Processed area-wide three-dimensional (3D) seismic data are available at the time of the first lease sale
- Industry would aggressively lease and explore the tracts offered
- Economic conditions (particularly oil and gas prices) would be high enough to support development in the Coastal Plain
- Undiscovered oil deposits will be discovered in all potential areas (high, medium, and low)
- Several industry groups will independently explore and develop new fields in the Coastal Plain
- Discoveries could be announced any time during a 10-year period (primary lease term) following lease sale
- Up to three anchor fields, with a minimum of 400 million barrels of proven producible reserves in each, would be discovered
- Future oil production would use existing North Slope infrastructure, including TAPS
- Production wells would likely have horizontal wellbores, with the lateral portion coinciding with the target formation
- Each producing horizontal oil well is assumed to require a horizontal injection well
- Once all wells are online for a particular field, assume 100,000 barrels of oil per day (peak production) for 3 years with an 8-percent annual production decline[1]
- The maximum production range from CPF to satellite pads is approximately 35 miles radius
- Production activities would continue year-round for 10 to 50 years, depending on field size. Production ends when the value of production cannot meet operating expenses.

E.5 RFD BASELINE SCENARIO

This baseline scenario projects a hypothetical projection of activity in the Coastal Plain assuming all potentially productive areas would be open to leasing subject to standard terms and conditions, except those areas designated as closed to leasing by law, regulation, or executive order. The activities and methods described in the baseline scenario are based on the activities typically associated with oil and gas operations on the North Slope of Alaska. For further description of typical activities and methods in the North Slope, see Section 4.2.1.2 of the National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement (BLM 2012).

The baseline RFD scenario is meant to convey the most likely unconstrained development scenario with no management restrictions except those mandated by law. The scenario provides the mechanism to analyze the effects that discretionary management decisions under the Coastal Plain Leasing EIS

[1] Peak production estimate based off of production projections for Willow and Armstrong developments on the North Slope. Decline estimate based off of standard decline estimates from the State of Alaska and the estimates used in NPR-A analyses.

alternatives would have on oil activity. Development activities and methods are not projected to vary from the baseline scenario unless noted in the descriptions of individual alternative scenarios.

Table E-3, below, describes the general time frames in which exploration, development, and production might occur in the Coastal Plain. As described in *Methodology and Assumptions for RFD Scenario Projections*, a time lag of at least eight years is expected between the first lease sale and the beginning of production. As previously discussed, the time frames below represent an optimistic, aggressive scenario. Activities occurring within five years of the signing of the Record of Decision (ROD) are considered short-term; activities occurring more than five years from ROD signature are considered long-term.

Table E-3
Estimated Development Time Frames

Project Phase	Time from ROD Signature	Activities
Three-dimensional (3D) Seismic Exploration	Complete by the time ROD is published	• Area-wide 3D seismic exploration
Leasing	Within 1 year of ROD	• First lease sale
Exploration	2 years after ROD (winter)	• First Application for Permit to Drill submitted for exploration well • First exploration well drilled • Assumes discovery with first exploration well
Additional Seismic Exploration	3 years after ROD (winter)	• Seismic exploration on lease block with discovery to locate future delineation exploration wells • Process seismic data and determine location of delineation wells to be drilled the following winter
Additional Exploration Wells	4 years after ROD (winter)	• Drill 3-5 additional wells to define the prospect and identify satellite pad locations
Master Development Plan and EIS	5-6 years after ROD	• Conduct NEPA analysis on Master Development Plan for anchor field • Continue drilling 2-3 exploration wells to identify CPF and satellite pad locations
Development	7 years after ROD	• Begin laying gravel for anchor pad, including CPF • Continue drilling 2-3 exploration wells to identify satellite pad locations • Begin drilling production

Project Phase	Time from ROD Signature	Activities
		wells on anchor pad
Production Begins	8 years after ROD	• First production from anchor pad • Winter gravel and construction on satellite pads
Production Increases	9-11 years after ROD	• All wells completed on anchor pad • All wells completed on satellite pads
Development of Additional Fields	11-50 years after ROD	• Construct facilities and drill wells in additional fields • Production continues for approximately 35 years after reaching peak production in each field

E.5.1 Leasing

The Tax Cuts and Jobs Act of 2017 (Public Law 115-97) mandates two lease sales: the first within four years and the second within seven years. In this scenario, it is assumed that the first sale would occur within one year of the publication of the Record of Decision (ROD) for the Leasing EIS. It is also assumed that 3D seismic studies would have been completed by the time the ROD is published. It is assumed that industry would lease areas offered and follow up with an aggressive exploration and development schedule.

E.5.2 Exploration

The BLM estimates that approximately 900 square miles would be surveyed, which would require approximately 500 miles of seismic lines to be traveled by seismic vehicles. All seismic exploration would be conducted using "Vibroseis" type seismic trucks, typically mounted on rubber tracks in order to minimize ground pressure. No air-guns or dynamite are expected to be used. Multiple vehicles could be used simultaneously miles apart to conduct "Vibroseis" exploration, or convoys of four to five trucks could travel in a line. The latter method is less common. Wireless geophone receivers (autonomous recording nodes) would be placed perpendicular to source lines. Receiver lines would be typically 330 to 1,320 feet apart. Seismic operations would be accompanied by ski mounted camp buildings towed by bulldozers or other tracked vehicles. There could be two to three strings with four to eight modular buildings in each string. Camps are assumed to move weekly. Seismic exploration activities will be further detailed in the Seismic Environmental Assessment, which is currently in preparation. All seismic operations would be conducted in the winter to minimize impacts on the tundra (Seismic EA).

Test wells would be drilled to confirm fields indicated by seismic results. Test wells would consist of a vertical borehole, typically drilled all the way to the bedrock (approximately 13,000 to 15,000 feet) in order to define the entire stratigraphic column. Water needed for ice pad construction and drilling muds could be imported, taken from nearby lakes and rivers, or from snowmelt; water demand would vary based on the site geology and the density of drilling mud required. A typical ice pad for exploration drilling is one foot thick and requires 500,000 gallons of water (DOI 2005). Current drilling technology is self-contained, so there are no reserve pits that could leak or pose an attractive nuisance to wildlife. Traditionally, drilling muds and cuttings had been placed in surface waste disposal impoundments known

as reserve pits. Using grind and inject technology, cuttings are now crushed and slurried with seawater in a ball mill, then combined with the remaining drilling muds and reinjected into a confining rock formation 3,000 to 4,000 feet underground in an approved injection well (DOI 2005). This reduces the environmental impacts associated with the disposal of drill cuttings as it avoids the need to bury cuttings on site or haul them out to a landfill. Drilling muds and additives are reconditioned and recycled to the extent possible. Drilling of a test well can take from 10 days to four weeks depending on how well the stratigraphic succession of the area is understood. Once the well is completed, additional down-well testing and characterization can take up to a month (DOI 2005).

Following a promising discovery made by a test well, delineation wells may be drilled to further characterize the discovery. These wells require similar resource commitments and require about the same time for drilling as a test well. After testing has been completed, test and delineation wells are sealed with cement to prevent oil and water from migrating between formations, and all wastes are removed from the site (DOI 2005).

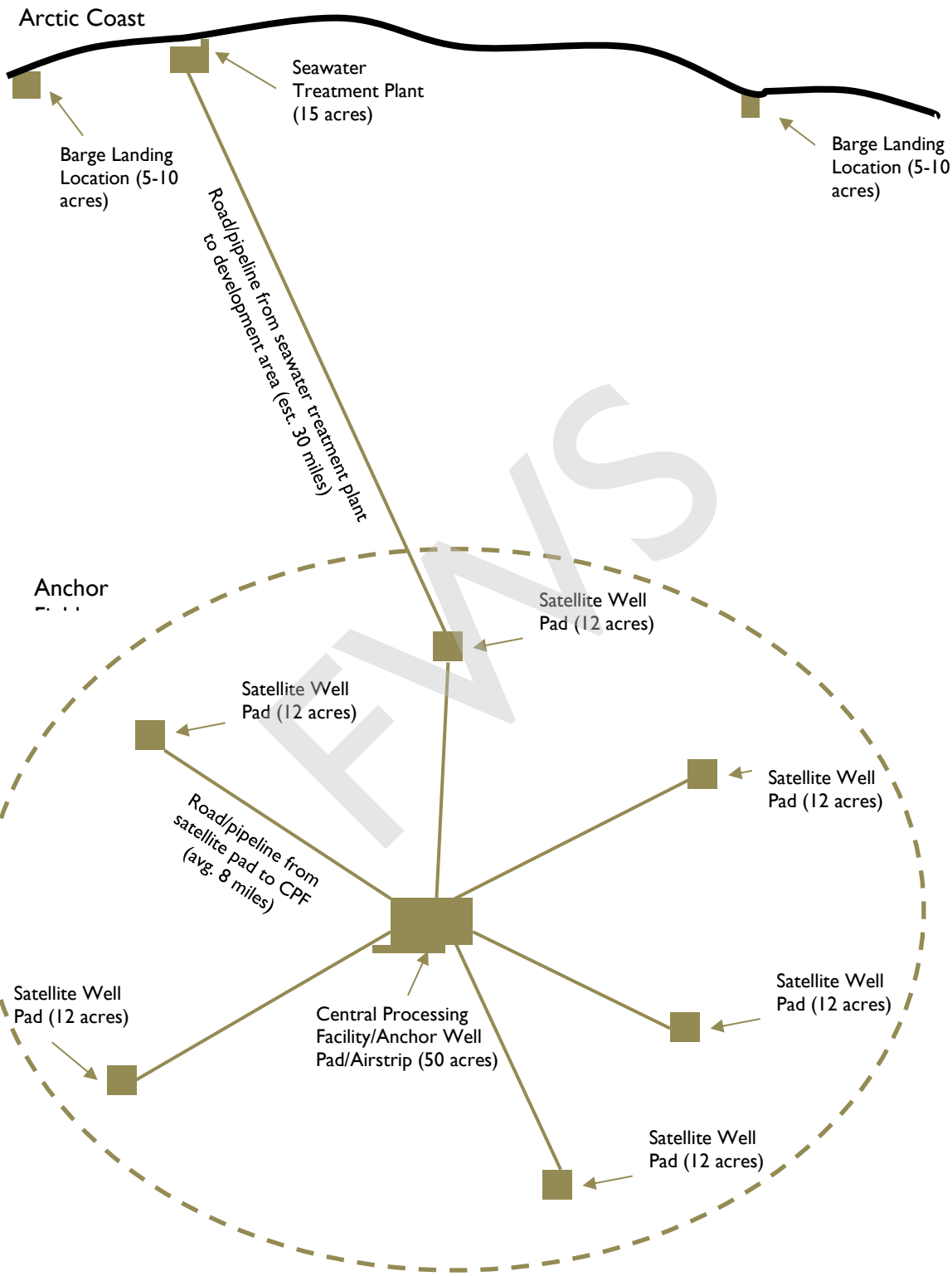
E.5.3 Development

For the purposes of this scenario it is assumed that economic conditions would remain favorable for the production of oil from the project area. It is also assumed that economically feasible oil accumulations would be discovered in all potential areas, and that multiple anchor fields (each containing at least 400 million barrels of proven producible reserves) would be discovered. It is also assumed that several different operators would independently explore and develop new fields in the Coastal Plain. See **Figure E-1**, Conceptual Layout of a Stand-alone Oil Development Facility, for a conceptual rendering of an anchor field and associated facilities.

In order to protect the tundra, ice roads would be used for most development activities. Ice roads are constructed seasonally and used to transport drill rigs, modular units, and other large or heavy equipment for central processing facilities (CPFs) and other supplies. They are constructed by compacting existing snow using low-ground pressure vehicles (approximately 1-2 pounds per square inch). The compacted tracks capture more snow blown by wind until they are compacted again after a week or two of accumulation. Once accumulation is complete, larger tracked vehicles with higher ground pressure or wheeled vehicles (such as a water truck or front-end loader) compact the snow to the desired road width. Water is then dispersed on the compacted snow to create ice buildup. The rate of ice buildup in cold conditions is approximately 1.5 inches per day. Using ice chips shaved from frozen lakes can increase the buildup rate to 4.5 inches per day and reduce the amount of water needed by approximately 75 percent. The minimum ice depth for use by full-size vehicles is six inches, and roads are typically 35 feet in width. Construction uses approximately one million gallons of water per mile, although use of ice chips can reduce water use substantially. Crews can construct about one mile per day (BLM 2012).

Snow trails can be used for smaller equipment, such as seismic trucks, camps, and maintenance vehicles. Low-ground pressure vehicles are used to pre-pack snow and groom trails if needed. Snow trails are typically thinner than ice roads and only wide enough for one vehicle. If snow trail maintenance is necessary, a tracked vehicle would tow a rounded groomer to smooth out the trail.

Figure E-1 Conceptual Layout of a Stand-alone Oil Development Facility*



*Facility locations and sizes are conceptual and are not to scale.

Development would start following the discovery of an anchor field. It is assumed that the first anchor field discovered would be in the western half of the Coastal Plain, most likely in the Topset play. Development would begin with the construction of a gravel pad for the wells, CPF, airstrip, storage tanks, communications center, waste treatment unit, and a camp for workers. Typically, these facilities occupy a total of 50 acres (BLM 2012). Most equipment for construction, including the modules for the CPF, would be transported to the anchor field on ice roads from a barge landing. Camden Bay has been identified as the most likely location for a barge landing (DOI 1987), although it is possible that operators could choose to use existing landing facilities at Point Thompson. Barge landing and an associated staging pad to store equipment and modules until ice roads can be constructed would require an approximately 10-acre gravel pad.

A seawater treatment plant would also be constructed along the coast, if needed. Groundwater aquifers or local lakes and rivers are the preferred water sources due to the cost and maintenance requirements of a seawater treatment plant. However, due to the limited amount of information about groundwater resources in the Coastal Plain we assume that those sources may not be sufficient to meet water needs and that, for the purposes of analysis, a seawater treatment plant would be required. Seawater treatment plants from other Arctic developments require approximately 15 acres of surface disturbance.[2] A road and seawater transport pipeline would be constructed from the seawater treatment plant to the CPF. Typical gravel roads in the arctic require 7.5 acres of surface disturbance per acre (BLM 2012).

Following the construction of the gravel anchor pad (for the CPF, airstrip, wells, and worker camp) facility construction and production drilling would begin. The CPF is the long-term operational center for production activities in a particular anchor field. It contains equipment for processing oil, gas, and water, including:

- Separators for oil, gas, and water, with an output of sales-quality oil
- Filtration of produced oil to extract solids
- Processing of associated gas to remove water and natural gas liquids, followed by gas compression and reinjection into the reservoir through gas injection wells
- Reinjection of water into the reservoir
- Compressors for gas and pumps for water injection

In addition to the CPF, a generator, airstrip, storage tanks, communications center, waste treatment units, and maintenance shop would be constructed on the anchor pad. Living quarters and offices may or may not be constructed on the anchor pad with the rest of the facilities. All buildings would be supported above ground on pilings to accommodate ground settling or frost heaving.

Production wells would extend horizontally in the target formation and take approximately 45 to 60 days to drill. This rate of drilling allows approximately eight wells to be drilled per year, thus taking about 4 years to drill the total of 30 wells on the average pad. Depending on drill rig availability, drilling could take place on multiple well pads at the same time. Drilling and completing each well would require anywhere from 420,000 to 1.9 million gallons of water to drill (BLM 2012). Wells would be hydraulically fractured for initial stimulation; however, this process requires less water than the multi-stage hydraulic

[2] Seawater treatment plant and gravel support pad at Prudhoe Bay measure 15 acres.

fracturing used in unconventional reservoirs. Water flooding using parallel injection wells would be used to maintain reservoir pressure and increase production. Water demand for maintaining reservoir pressure is proportional to the oil production from the field; a field with a daily production rate of 50,000 barrels of oil per day would require approximately 2 million gallons of water per day. The anchor pad would have a Class I or Class II disposal well, or both, which are used to dispose of industrial wastes and fluids associated with oil and gas production respectively (EPA 2018). Solid, non-burnable waste would be disposed of in large dumpsters or approved containers and hauled back to approved offsite landfills. Onsite burial of solid wastes is not anticipated.

A production pipeline would be constructed to connect the CPF to the Trans-Alaska Pipeline System (TAPS) in order to move produced oil to market. Vertical support members (VSMs) are counted as ground disturbance at a rate of approximately 0.04 acres per mile (USACE 2017). Pipelines would also connect each satellite pad (once constructed) to the nearest CPF. Pipelines for water, fuel, and electric cables to supply satellite pads would also be run on the same VSMs.

Following the completion of the anchor pad, development would begin on satellite pads around the anchor field. Satellite pads would consist of wells and the minimum amount of required equipment and pump production back to the nearest CPF via pipeline for processing. Satellite pads in the Coastal Plain are each anticipated to contain approximately 30 wells and occupy approximately 12 acres of surface disturbance.[3] In this analysis, we assume that satellite pads could be used to produce from areas of the anchor field that are not accessible from the anchor pad or could be used to produce from smaller fields that would not be economically viable if they needed a dedicated CPF.

Unconventional Development

No unconventional development is anticipated in the Coastal Plain in the time period analyzed in this RFD. There is currently no unconventional oil and gas production on Alaska's North Slope; due to the high costs of and difficult operating conditions in the arctic, the viability of hydraulic fracturing to produce from unconventional petroleum resources has not been proven from a technology or commercial viability standpoint (BLM 2012). Coalbed methane potential is unknown but production is unlikely due to a lack of infrastructure to transport gas from northern Alaska to market.

E.5.4 Production

Once all wells in a development are online, production is anticipated to peak at 100,000 barrels per day[4] from each field after three years. From that point onward, production is estimated to decline at a rate of approximately eight percent per year.[5] Produced resources would be processed at the CPF to separate water and gas from saleable oil and natural gas liquids. Water and gas would be reinjected into the formation to enhance oil recovery; oil and natural gas liquids would be shipped to market via TAPS. Field production can last from 10 to 50 years before abandonment (BLM 2012). In the Coastal Plain, assuming the 100,000 barrel-per-day peak production and the eight-percent decline per year, it is estimated to take 35 years after reaching peak production to get to the point of abandonment of a field.

[3] Nanushuk DEIS measured 2.75 acres of pad per well, Alpine well-head area is approximately 2.5 acres per well for newer well pads.

[4] Estimate based off of production projections for Willow and Armstrong developments on the North Slope.

[5] Estimate based off of standard decline estimates from the State of Alaska and the estimates used in NPR-A analyses.

Re-injection of produced gas and water helps maintain oil reservoir energy and improve hydrocarbon recovery efficiency by pushing oil towards the production wells, increasing the ultimate oil recovery. Associated gas and water injection wells are needed where no gas sales line exists and where water disposal is not allowed at the surface (BLM 2012).

Depending on market forces, the size and number of fields discovered, and the timing of development, the ultimate recovery in the Coastal Plain is estimated to be anywhere from 1.5 BBO to 10 BBO based on the estimated daily production rate for the three main developments in the Coastal Plain. Production rates and estimated ultimate recovery are not expected to change significantly under any alternative scenario. This is because the management under the alternatives is expected to change the configuration of facilities but not the total amount of production. Minor changes in the amount of production cannot be predicted at this time, given the limited data on the formations and resources in the Coastal Plain.

E.5.5 Abandonment and Reclamation

Abandonment and reclamation occurs once a well pad or field is no longer producing enough oil to cover costs. Typically, abandonment and reclamation takes from two to five years following the termination of production (BIA 2012). Wells are plugged with cement to prevent fluid migration between formations, and the well casing is cut and plugged below the surface and buried. On-site equipment, facilities, and solid wastes are removed from the site. Gravel from pads is removed and reused or placed back in the gravel pit it was originally extracted from. Pipelines and VSMs are removed and scrapped or reused in other development.

Once all satellite pads feeding to a CPF are no longer producing or when the flow of produced oil is reduced to the point that operation is no longer economically viable, the CPF would be decommissioned.

E.6 Coastal Plain Leasing EIS Alternative Scenarios

E.6.1 Alternative A

Under Alternative A (the No Action Alternative), no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales following the ROD for the Leasing EIS. Alternative A would not include the direction under the Tax Cuts and Jobs Act of 2017 to establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain within the Arctic Refuge. Under this alternative, current management actions would be maintained and resource trends would continue, as described in the Arctic National Wildlife Refuge Revised Comprehensive Conservation Plan (USFWS 2015). Alternative A is being considered in order to provide a baseline for the comparison of impacts under the action alternatives.

Because no leasing, exploration or development would occur under this alternative, no production would occur, and no surface disturbance would be created.

E.6.2 Alternative B

Due to minimal restrictions and stipulations under this alternative, development would be expected to occur in approximately the same manner as the baseline scenario. In the long-term it is anticipated that three CPFs would be built, two in the high-potential area and one in the medium-potential area south of Kaktovik. Under this alternative, it is assumed that one CPF could be located on state or native lands. It is assumed that approximately 19 satellite pads would be developed (in addition to the three production

pads associated with the CPFs). Approximately 219 miles of gravel road would be needed to connect facilities. It is expected that one seawater treatment plant and one barge landing and storage pad would be needed. It is anticipated that under this alternative the 2,000-acre surface disturbance cap would be reached. See *Surface Disturbance Due to Oil and Gas*, below for more details on the surface disturbance created under this alternative.

E.6.3 Alternative C

Under this alternative, development would be expected to occur as in approximately the same manner as the baseline scenario. In the long-term it is projected that three CPFs would be built, two in the high potential-area and one in the medium-potential area south of Kaktovik. It is assumed that approximately 19 satellite pads would be developed (in addition to the three production pads associated with the CPFs). Approximately 212 miles of gravel road would be needed to connect facilities. It is expected that one seawater treatment plant and one barge landing and storage pad would be needed. It is anticipated that under this alternative the 2,000-acre surface disturbance cap would be reached. See *Surface Disturbance Due to Oil and Gas*, below for more details on the surface disturbance created under this alternative.

E.6.4 Alternative D1

Due to restrictions and stipulations under this alternative, the potential locations for drill pads and CPFs could be limited, and pad configurations could change. In the long-term it is projected that two CPFs would be built, one in the high-potential area and one in the medium-potential area south of Kaktovik. It is assumed that approximately 20 satellite pads would be developed (in addition to the two production pads associated with the CPFs). Approximately 217 miles of gravel road would be needed to connect facilities. We expect that one seawater treatment plant and one barge landing and storage pad would be needed. It is anticipated that under this alternative the 2,000-acre surface disturbance cap would be reached. See *Surface Disturbance Due to Oil and Gas*, below for more details on the surface disturbance created under this alternative.

E.6.5 Alternative D2

Due to restrictions and stipulations under this alternative, the potential locations for drill pads and CPFs could be limited, and pad configurations could change. In the long-term, it is projected that two CPFs would be built, one in the high-potential area and one in the medium-potential area south of Kaktovik. It is assumed that approximately 20 satellite pads would be developed (in addition to the two production pads associated with the CPFs). Approximately 217 miles of gravel road would be needed to connect facilities. It is expected that one seawater treatment plant and one barge landing and storage pad would be needed. It is anticipated that under this alternative the 2,000-acre surface disturbance cap would be reached. See *Surface Disturbance Due to Oil and Gas*, below for more details on the surface disturbance created under this alternative. Because a timing limitation stipulation would be applied to the entire Coastal Plain under this alternative, the time frames for reaching peak production could be extended compared with the other action alternatives.

E.7 Surface Disturbance Due To Oil Development

E.7.1 Production Facilities

A CPF is the operational center for long term production activities. A typical pad for a CPF and associated facilities, which include an airstrip, workers camp, and production well pad, is approximately

50 acres (BLM 2012). Similar projects estimate gravel needs at 10,000 cubic yards per acre (BLM 2012) for a total of 500,000 cubic yards per 50-acre CPF.

A typical satellite well pad in the Coastal Plain is projected to have approximately 30 wells and occupy approximately 12 acres. A well pad of this size would require approximately 120,000 cubic yards of gravel.[6]

E.7.2 Support facilities

A seawater treatment plant supplies water needed for drilling and waterflooding. The total area for comparable Arctic seawater treatment plants and their required support pads is approximately 15 acres. A pad of this size would require approximately 150,000 cubic yards of gravel.

E.7.3 Roads and pipelines

Roads from similar developments create a ground disturbance of approximately 7.5 acres per mile (BLM 2012). Roads are projected to be the greatest source of disturbance associated with petroleum development in the Coastal Plain. Depending on the alternative, it is estimated that anywhere from 1,550 to 1,650 acres of road could be built. Road requirements are somewhat elastic in that operators could potentially route roads through native or state lands or even build some roadless developments if there were a possibility of the 2,000-acre disturbance cap being exceeded.

Pipelines would be used to transport oil to the CPFs and eventually to TAPS. They are also used to transport water, fuel, and electricity to satellite pads. Pipeline VSMs are counted towards the 2,000-acre disturbance cap, but spans are not. VSMs in the Arctic create approximately 0.04 acres of surface disturbance per pipeline mile (BLM 2012). It is estimated that approximately 210 to 250 miles of pipeline would be constructed in the Coastal Plain depending on field design; this would cause approximately 8.4 to 10 acres of ground disturbance.

E.7.4 Gravel pits

Pits would be constructed to supply gravel needs for pads and roads. Gravel could be sourced from hard rock or unconsolidated sand and gravel deposits depending on what sources is available in the area surrounding development. Due to the number of outcrops and surface deposits in the Coastal Plain, it is anticipated that pits would be constructed adjacent to facilities or roads used for satellite access and that additional road construction would not be needed to access gravel pits. In estimating gravel pit sizes, we created a low-disturbance case assuming that pits would be excavated to a 50-foot depth as is industry standard practice, and a maximum-disturbance case assuming an average pit depth of 25 feet in the case of technical challenges such as water infiltration or material not adhering well enough in side slopes to reach full excavation depth. In the low-disturbance case, approximately 150 to 160 acres of surface disturbance would be required to supply all Coastal Plain gravel needs, in the maximum disturbance case, approximately 300 to 320 acres of surface disturbance would be required to supply Coastal Plain gravel needs.

[6] Based on gravel need estimates from NPR-A IAP/EIS.

The Bureau of Land Management's (BLM) interpretation of the Tax Cuts and Jobs Act of 2017 is that gravel pits are not an oil and gas production or support facility and thus do not count towards the 2,000-acre surface disturbance cap.

E.7.5 Surface Disturbance Estimates

Table E-4
Estimated Surface Disturbance by Facility

Baseline facility sizes[7]	Acres of surface disturbance	
CPF, Airstrip, anchor well pad	50	
Satellite Pads	12	
Gravel roads connect CPF to satellites	7.5	per mile
VSMs	0.04	per mile
Seawater Treatment Plant	15	
Barge landing and equipment storage	10	

Sources: BLM 2004, BLM 2012, USACE 2017

Table E-5
Projected Facilities and Surface Disturbance by Alternative[1]

	Alternative B		**Alternative C**		**Alternatives D1 and D2 (and Baseline Scenario)**	
Facility Type	Number of Facilities	Acres	Number of Facilities	Acres	Number of Facilities	Acres
CPF, Airstrip, anchor well pad	2	100	3	150	2	100
Satellite Pads	19	230	19	230	20	240
Roads: CPF to satellites	219mi	1635	212mi	1585	217mi	1625
VSMs	219mi	10	212mi	10	217mi	10
Seawater Treatment Plant	1	15	1	15	1	15
Barge landing and storage	1	10	1	10	1	10
Total (approx.)		**2000**		**2000**		**2000**

Sources: BLM 2004, BLM 2012, USACE 2017

[1]All facility numbers and surface disturbance acreages are general estimates and are not based on specific project proposals. Acreages are rounded to the nearest 5 acres.

E.8 ECONOMIC IMPACTS

The leasing and subsequent development of oil and gas resources in the Coastal Plain would have direct and indirect economic impacts on the economy. **Table E-6**, Projected Direct and Indirect Labor Income: Exploration, Development, and Production Phases, estimates the number of direct and indirect jobs that would be created as a result of exploration, development, and production in the Coastal Plain.

[7] Baseline facility sizes were determined based on facility sizes from comparable North Slope projects, such as Alpine, and the professional expertise of BLM and Alaska Department of Natural Resources staff.

Table E-6
Projected Direct and Indirect Jobs: Exploration, Development, and Production Phases

Jobs (average number of part-time and full-time jobs)	Annual Average	Peak
Direct Effects		
Exploration	250	650
Development	480	680
Production	730	1,150
Indirect Effects		
Exploration	190	560
Development	3,180	4,570
Production	3,160	4,970

Source: Northern Economics estimates based on the following models and data sources: i) Alaska Department of Natural Resources Cash Flow model (modified for use in this analysis), ii) MAG-PLAN model (used to estimate some of the capital expenditures); iii) Spring 2018 Revenue Forecast published by the Alaska Department of Revenue (for data on transportation costs); iv) Annual Energy Outlook 2018 published by the Energy Information Administration (for data on oil price projections); v) IMPLAN model (used to estimate direct, indirect, induced effects); vi) Attanasi and Freeman 2009 (used to estimate some capital expenditures of petroleum development).

Direct and indirect income projected to be created by Coastal Plain development is shown in **Table E-7**, Projected Direct and Indirect Labor Income: Exploration, Development, and Production Phases.

Table E-7
Projected Direct and Indirect Labor Income: Exploration, Development, and Production Phases

Labor Income (millions of 2017$)	Annual Average	Peak
Direct Effects		
Exploration	$29	$77
Development	$97	$140
Production	$125	$197
Indirect Effects		
Exploration	$10	$30
Development	$214	$307
Production	$212	$307

Source: Northern Economics estimates based on the following models and data sources: i) Alaska Department of Natural Resources Cash Flow model (modified for use in this analysis), ii) MAG-PLAN model (used to estimate some of the capital expenditures); iii) Spring 2018 Revenue Forecast published by the Alaska Department of Revenue (for data on transportation costs); iv) Annual Energy Outlook 2018 published by the Energy Information Administration (for data on oil price projections); v) IMPLAN model (used to estimate direct, indirect, induced effects); vi) Attanasi and Freeman 2009 (used to estimate some capital expenditures of petroleum development).

Government revenues projected to be created by Coastal Plain development are shown in **Table E-8**, Projected NSB, State, and Federal Government Revenues.

Table E-8
Projected NSB, State, and Federal Government Revenues

Government Revenues (in millions of 2017$)	Annual Average	Total
NSB Property Taxes	$52	$1,192
State Royalties	$894	$21,463
State Taxes	$2,151	$49,473

Government Revenues (in millions of 2017$)	Annual Average	Total
Federal Royalties	$894	$21,463
Federal Taxes	$462	$11,082

Source: Northern Economics estimates based on the following models and data sources: i) Alaska Department of Natural Resources Cash Flow model (modified for use in this analysis), ii) MAG-PLAN model (used to estimate some of the capital expenditures); iii) Spring 2018 Revenue Forecast published by the Alaska Department of Revenue (for data on transportation costs); iv) Annual Energy Outlook 2018 published by the Energy Information Administration (for data on oil price projections); v) Attanasi and Freeman 2009 (used to estimate some capital expenditures of petroleum development).

Additionally, local governments would benefit from tax revenues from local taxes captured from workers and additional local income.

The stipulations applied under Alternative B, C, D1, and D2 could result in unquantifiable diversions from the baseline scenario presented above. The impacts associated with stipulations could result in additional consultations with stakeholders, studies for permitting, delays for timing limitations, construction of additional facilities and infrastructure. Some of these actions could result in higher employment and income effects due to additional expenditures that would be necessary to comply the required operating procedure, including additional spending on consultation, and studies. Some of these actions could also result in delays in exploration, development, and production activities and would therefore also delay potential employment and income effects as well as revenues that could accrue to the local, state, and federal governments.

E.9 REFERENCES

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Appendix F
Paleontological Resources

Potential Fossil Yield Classification System

Introduction. The Potential Classification Yield Classification (PFYC) system allows Bureau of Land Management (BLM) employees to make initial assessments of paleontological resources in order to plan for multiple uses of public lands, consider disposal or acquisition of lands, analyze potential effects of a proposed action under the National Environmental Policy Act (NEPA), or conduct other BLM resource-related activities. The PFYC system can also highlight the areas for paleontological research efforts or predict illegal collecting. The system provides a consistent and streamlined approach to determine if a potential action may affect paleontological resources on public lands.

The PFYC system provides baseline guidance for assessing paleontological resources. The classification should be considered early in an analysis and should be used to assist in determining the need for further assessment or actions. When considering proposed actions, the PFYC system should be used in conjunction with a map of known fossil localities.

Occurrences of paleontological resources are known to be correlated with mapped geologic units (i.e., formations). The PFYC is created from available geologic maps and assigns a class value to each geological unit, representing the potential abundance and significance of paleontological resources that occur in that geological unit. PFYC assignments should be considered as only a first approximation of the potential presence of paleontological resources, subject to change based on ground verification.

In the PFYC system, geologic units are assigned a class based on the relative abundance of significant paleontological resources and their sensitivity to adverse impacts. This classification is applied to the geologic formation, member, or other mapped unit. The classification is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit that has been assigned a lower PFYC classification, widely scattered important fossils or localities do not necessarily indicate a higher class assignment. Instead, the overall abundance of scientifically important localities is intended to be the major determinant for the assigned classification.

The descriptions for the class assignments below serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual geological units are considered when developing PFYC assignments. These assignments must be developed using scientific expertise with input from a BLM paleontologist, but may include collaboration and peer review from outside researchers who are knowledgeable about both the geology and the nature of paleontological resources that may be found in each geological unit. Each state has unique geologic maps and so also has unique PFYC assignments. It is possible, and occasionally desirable, to have different assignments for a similar geologic unit across separate states.

Class 1 – **Very Low**. Geologic units that are not likely to contain recognizable paleontological resources. Units assigned to Class 1 typically have one or more of the following characteristics:

- Geologic units are igneous or metamorphic, excluding air-fall and reworked volcanic ash units.
- Geologic Units are Precambrian in age.

(1) Management concerns for paleontological resources in Class 1 units are usually negligible or not applicable.

(2) Paleontological mitigation is unlikely to be necessary except in very rare or isolated circumstances that result in the unanticipated presence of paleontological resources, such as unmapped geology contained within a mapped geologic unit. For example, young fissure-fill deposits often contain fossils but are too limited in extent to be represented on a geological map; a lava flow that preserves evidence of past life, or caves that contain important paleontological resources. Such exceptions are the reason that no geologic unit is assigned a Class 0.

Overall, the probability of impacting significant paleontological resources is very low and further assessment of paleontological resources is usually unnecessary. An assignment of Class 1 normally does not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.

Class 2 – **Low**. Geologic units that are not likely to contain paleontological resources. Units assigned to Class 2 typically have one or more of the following characteristics:

- Field surveys have verified that significant paleontological resources are not present or are very rare.
- Units are generally younger than 10,000 years before present.
- Recent aeolian deposits.
- Sediments exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely.

(1) Except where paleontological resources are known or found to exist, management concerns for paleontological resources are generally low and further assessment is usually unnecessary except in occasional or isolated circumstances.

(2) Paleontological mitigation is only necessary where paleontological resources are known or found to exist.

The probability of impacting significant paleontological resources is low. Localities containing important paleontological resources may exist, but are occasional and should be managed on a case-by-case basis. An assignment of Class 2 may not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate unanticipated discoveries.

Class 3 – **Moderate**. Sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Units assigned to Class 3 have some of the following characteristics:

- Marine in origin with sporadic known occurrences of paleontological resources.
- Paleontological resources may occur intermittently, but abundance is known to be low.
- Units may contain significant paleontological resources, but these occurrences are widely scattered.
- The potential for an authorized land use to impact a significant paleontological resource is known to be low-to-moderate.

(1) Management concerns for paleontological resources are moderate because the existence of significant paleontological resources is known to be low. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for casual collecting.

(2) Paleontological mitigation strategies will be proposed based on the nature of the proposed activity.

This classification includes units of moderate or infrequent occurrence of paleontological resources. Management considerations cover a broad range of options that may include record searches, pre-disturbance surveys, monitoring, mitigation, or avoidance. Surface-disturbing activities may require assessment by a qualified paleontologist to determine whether significant paleontological resources occur in the area of a proposed action, and whether the action could affect the paleontological resources.

Class 4 – **High**. Geologic units that are known to contain a high occurrence of paleontological resources. Units assigned to Class 4 typically have the following characteristics:

- Significant paleontological resources have been documented, but may vary in occurrence and predictability.
- Surface disturbing activities may adversely affect paleontological resources.
- Rare or uncommon fossils, including nonvertebrate (such as soft body preservation) or unusual plant fossils, may be present.
- Illegal collecting activities may impact some areas.

(1) Management concerns for paleontological resources in Class 4 are moderate to high, depending on the proposed action.

(2) Paleontological mitigation strategies will depend on the nature of the proposed activity, but field assessment by a qualified paleontologist is normally needed to assess local conditions.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation plans must consider the nature of the proposed disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access that could result in looting. Detailed field

assessment is normally required and on-site monitoring or spot-checking may be necessary during land disturbing activities. In some cases avoidance of known paleontological resources may be necessary.

Class 5 – **Very High**. Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources. Units assigned to Class 5 have some or all of the following characteristics:

- Significant paleontological resources have been documented and occur consistently.
- Paleontological resources are highly susceptible to adverse impacts from surface disturbing activities.
- Unit is frequently the focus of illegal collecting activities.

(1) Management concerns for paleontological resources in Class 5 areas are high to very high.

(2) A field survey by a qualified paleontologist is almost always needed. Paleontological mitigation may be necessary before or during surface disturbing activities.

The probability for impacting significant paleontological resources is high. The area should be assessed prior to land tenure adjustments. Pre-work surveys are usually needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designation of areas of avoidance, or special management designations should be considered.

Class U **– Unknown Potential.** Geologic units that cannot receive an informed PFYC assignment. Characteristics of Class U may include:

- Geological units may exhibit features or preservational conditions that suggest significant paleontological resources could be present, but little information about the actual paleontological resources of the unit or area is known.
- Geological units represented on a map are based on lithologic character or basis of origin, but have not been studied in detail.
- Scientific literature does not exist or does not reveal the nature of paleontological resources.
- Reports of paleontological resources are anecdotal or have not been verified.
- Area or geologic unit is poorly or under-studied.
- BLM staff has not yet been able to assess the nature of the geologic unit.

(1) Until a provisional assignment is made, geologic units that have an unknown potential have medium to high management concerns.

(2) Lacking other information, field surveys are normally necessary, especially prior to authorizing a ground-disturbing activity.

An assignment of "Unknown" may indicate the unit or area is poorly studied, and field surveys are needed to verify the presence or absence of paleontological resources. Literature searches or consultation with professional colleagues may allow an unknown unit to be provisionally assigned to another Class, but the geological unit should be formally assigned to a Class after adequate survey and research is performed to make an informed determination.

***Class W* – Water.** Includes any surface area that is mapped as water. Most bodies of water do not normally contain paleontological resources. However, shorelines should be carefully considered for uncovered or transported paleontological resources. Reservoirs are a special concern because important paleontological resources are often exposed during low water intervals. In karst areas sinkholes and cenotes may trap animals and contain paleontological resources. Dredging river systems may result in the disturbance of sediments that contain paleontological resources.

***Class I* – Ice.** Includes any area that is mapped as ice or snow. Receding glaciers, including exposed lateral and terminal moraines should be considered for their potential to reveal recently exposed paleontological resources. Other considerations include melting snow fields that may contain paleontological resources with possible soft-tissue preservation.

Special Notes. When developing PFYC assignments, the following should be considered:

- Standard stipulations should always be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.
- Class 1 & 2 and Class 4 & 5 units may be combined for broad applications, such as large-scale planning, programmatic assessments, or when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations will need to be addressed when actual land disturbing activities are proposed.
- Where large projects impact multiple geologic units with different PFYC Classes, field survey and monitoring should be applied appropriately. For example, the authorized officer may determine that on-the-ground (pedestrian) surveys are necessary for the Class 4 and 5 formations, but not for Class 2 formations along a specific project.
- Based on information gained by surveys, the BLM may adjust PFYC assignments appropriately. Actual survey and monitoring intensities, as well as the extent of discoveries, should be included in any assessment, mitigation, or permit report so the BLM may reevaluate PFYC assignments.
- A geologic unit may receive a higher or lower classification in specific areas where the occurrence of fossils is known to be higher or lower than in other areas where the unit is exposed.
- Some areas are difficult to evaluate, such as talus, colluvium, tailings, fill, borrow, and other mapped features. A PFYC assignment should be made for each area using available information, or the area should be assigned to Class U as appropriate.
- The BLM-wide PFYC assignments are maintained and periodically updated by the BLM paleontology team and may be obtained by contacting the BLM state or regional paleontologist assigned to an area.

Arctic Coastal Plain Geologic Units' PFYC Descriptions

Note: the Potential Fossil Yield Classification (PFYC) model for Alaska is in development as of August 2018; the excerpts below are preliminary PFYC rankings and descriptions for selected units in the program area.

Source: Breithaupt, B. BLM Regional Paleontologist, e-mail to Anna Kohl, HDR environmental scientist, on July 30, 2018, regarding preliminary PFYC rankings and unit descriptions for the program area.

Unconsolidated and poorly consolidated surficial deposits Quaternary Deposits
PFYC: 2-3
Most Quaternary, Pleistocene, and uppermost Tertiary deposits have not been given formation names and are frequently mapped based on lithologic character and estimated age. Care should be taken with these deposits with regard to fossil resources, as it is very hard to predict with deposits might be fossiliferous. Many of these types of deposits contain significant floras and faunas, although the distribution of fossils is often spotty. These deposits should not be underestimated for their fossil potential. Recent, Holocene and disturbed deposits are ranked very low potential for obvious reasons.

Sagavanirktok Formation (Tertiary)
PFYC: 3-4
Contains floral fossils (Gryc et al. 1951). Fossil flora was collected from the Sagwon Member of this formation (Metasequuoia occidentalis, Trapa microphylla, Cinnamononum ficoides; Spicer et al. 1994); no fossils from the Franklin Bluffs Member and not likely to produce any; the Nuwok Member contains molluscan fossils and prolific microfauna (foraminifers and ostracodes; Detterman et al. 1975). Mull et al. (2003) added the White Hills Member in addition to the Sagwon, Franklin Bluffs, and Nuwok Members. Molluscan fossils in what used to unofficially be called the Nuwok Formation (MacNeil 1957).

Jago River Formation (Upper Cretaceous)
PFYC: 3
Palynomorphs, plant fossils (Buckingham 1987; Molenaar et al. 1987).
The Bathtub Graywacke is included in this formation, which doesn't contain any invertebrate fossils, has some plant fossils, but the only identifiable material was an Equisetum, and a few fragments of the marine algae Tyttodiscus (Detterman et al. 1975).

Prince Creek Formation (Upper Cretaceous)
PFYC: 5
Fresh- to brackish-water molluscs (Gryc et al. 1951). This formation was separated into two tongues and in the Kogosukruk Tongue macrofossils are rare, but consist of fresh- to brackish-water pelecypods and gastropods (Gryc et al. 1951). Both tongues contain a fair amount of plant material (stems, twigs, leaves) and forms carbonaceous shale in some spots (Detterman et al., 1975). Theropod teeth (Fiorillo and Gangloff 2000). Dinosaur bones galore from the Liscomb Bonebed.

Mull et al. (2003) revised this formation to consist of beds originally assigned to the Kogosukruk tongue (which they abandoned) and brown-weathering, coal-bearing rocks originally assigned to lower part of Sagwon Member of Sagavanirktok Formation. Mull et al. (2003) revised the Tuluvak tongue to be its own formation. A section was described that includes dinosaur-bone bearing beds at Ocean Point on the Colville River 60 mi downstream from Umiat (Phillips 1988, 1990 cited in Mull et al. 2003). Conifer, Sycamore-like, gymosperms, pelecypods, gastropods, plants and some microfossils (Lindsey 1986).

Arctos database: Hadrosaurs and many other dinosaur fossils.
Actinopterygii, Aves, bivalves.

Canning Formation (Cretaceous-Tertiary)
PFYC: U

Seabee Formation (Upper Cretaceous)
PFYC: 4
Marine fossils including Scaphites delicatulus, Borissjakoceras (ammonites) and Inoceramus (Gryc et al., 1951). Pelecypod and ammonite megafauna and microfauna in lower part of formation, Foraminifera and palynomorphs in upper part of formation (Mull et al. 2003). Pelecypods, ammonitse, fish scales and vertebrae (Lindsey 1986). Arctos database: Therapod or small bird trace fossil (footprint).

Hue Shale (Lower Cretaceous)
PYFC: 3
Includes a bed that is rich in Inoceramus bivalve prisms, fish remains and more Inoceramus prisms are found higher in the formation, and palynomorphs (Molenaar et al. 1987).

Kemik Sandstone (Lower Cretaceous)
3PFYC: 2-3
Previously a member of the Kongakut Formation. Molenaar (1988) mentions a couple marine mollusk fossils that were collected below this formation, but not that they are from this formation particularly. Trace fossils Skolithos, Dioplocraterion, Arenicolites, and Ophiomorpha (Reifenstuhl 1995). Arctos database: belemnite guards.

Tupik Formation (Lisburne Group) (Carboniferous)
PFYC: 3
Fossils are rare but include brachiopods and gastropods (Campbell 1967). Abundant sponge spicules, radiolarians, and cephalopods (Moore et al. 1994).

Kogruk Formation (Lisburne Group) (Carboniferous)
PFYC: 3
Some crinoidal debris, horn corals, brachiopods (Sable and Dutro 1961). Corals and brachiopods (Lindsey 1986). Corals (Dutro 1987).

Wahoo Limestone (Lisburne Group) (Carboniferous)
PFYC: 3
Lower part of unit has a brachiopod-bryozoan assemblage and corals, the upper part contains brachiopods (Brosgé et al. 1962). Contains some rugose and tabulate corals, but not very abundant (Armstrong and Mamet 1977). Colonial corals Corwenia jagoensis and Lithostrotionella wahooensis (Armstrong 1972

Alapah Limestone (Lisburne Group) (Carboniferous)
PFYC: 3
Lithostrotionoid corals, broken shells, fish teeth (Bowsher and Dutro 1957); molluscs, brachiopods, corals, and gastropods (Dutro 1987). Ammonites, plants, Nautiloids (Lindsey 1986).

Kuna Formation (Lisburne Group) (Carboniferous)
PFYC: 3
Long ranging brachiopod fauna, conodonts, radiolarians (Mull et al. 1982). Cephalopods, molluscs, brachiopods, corals (Dutro 1987). Fossils are rare; conodonts and radiolarians have been recovered (Dumoulin et al. 1993).

Akmalik Chert (Lisburne Group) (Carboniferous)
PFYC: 3
Plant fossil imprint (unnamed genus at the time of publication), radiolarians, conodonts (Mull et al. 1987). Radiolaria, a single plant fossil that wasn't specified and had an unknown stratigraphic position, conodonts (Blome et al. 1998).

Nasorak Formation (Lisburne Group) (Carboniferous)
PFYC: 3
Fossils are common and include crinoid columnals, bryozoa, brachiopods, horn and lithostrotionoid corals, and foraminifera (Campbell 1965). Plant fossils (Dutro 1987).

Utukok Formation (Lisburne Group) (Carboniferous)
PFYC: 3
Brachiopods, crinoidal debris, gastropods, cephalopods, pelecypods (Sable and Dutro 1961). Brachiopods, gastropods, pelecypod (Lindsey 1986). Abundant horn corals, brachiopods, bryozoans (Dutro 1987).

Wachsmuth Limestone (Lisburne Group) (Carboniferous)
PFYC: 3
Coral and brachiopods (Bowsher and Dutro 1957). Only corals mentioned (Brosgé et al. 1962). Gastropods, unidentified molluscs (Lindsey 1986).

Ivishak Formation (Sadlerochit Group) Triassic)
PFYC: 3
Contains ammonoids (Keller et al. 1961). Includes the Kavik Member, Ledge Sandstone Member, Fire Creek Siltstone Member (Detterman et al. 1975). The Kavik Member contains ammonites, pelecypods, and few microfossils; the Ledge Sandstone Member has sparse brachiopods and ammonites, most of which are fragmentary; and the Fire Creek Siltstone Member contains sparse Euflemingites ammonites and Lingula brachiopods (Detterman et al. 1975).

Echooka Formation (Sadlerochit Group) (Permian)
PFYC: 3
Keller et al. (1961) say it's fossiliferous, but don't say what kinds of fossils. Raised to the formation level and divided into two members by Detterman et al. (1975). The upper part of the Joe Creek Member is abundantly fossiliferous with brachiopods and the lower part has more sparse fossils; also contains abundant bryozoans and corals and some trilobites and pelecypods (Detterman et al. 1975).

Kongakut Formation (Lower Cretaceous)
PFYC: 2-3
Buchia shells, some poorly preserved pelecypods, and some microfossils that indicate a similarity to Barremian rocks of the Richardson Mountains in the Yukon Territory (Detterman et al. 1975).

Kingak Shale (Jurassic)
PFYC: 3
Crinoids, bivalves, cephalopods, and ammonites (Leffingwell 1919).
Marine molluscs (bivalves, ammonites, cephalopods, ammonites) and crinoids (Payne et al. 1951). Early Jurassic fossils in northeast Alaska are sparse but include pelecypods, crinoids are also present in the formation as well as ammonites and microfossils associated with pelecypods and ammonites (Detterman et al. 1975). Ammonites from the early Jurassic, but aren't abundant or well preserved (Lindsey 1986).

Arctos database: guards from Belemnoidea.

Nanushuk Formation (Upper Cretaceous)
PFYC: 5
Variety of bivalve genera, Avicula. (Avicularia? a tarantula genus), a few other insect genera (Schrader 1902). No reference to tarantula or insect fossils were found in any other references though. The marine beds contain a variety of megafauna including pelecypods, gastropods, and ammonites; non-marine beds contain plant fossils (Mull et al. 2003). Sequoia-like cones and foliage, foliage of Taxaceae, conifer wood, Ginkgos, cycad, ferns, dicots (Lindsey 1986). Fossil plants including ferns, cycads, ginkgos, conifers, and angiosperms, which used to be part of the Corwin Formation before it was reallocated to the Nanushuk (Lindsey 1986). Arctos database: dinosaur trace fossils (footprints), dinosaur tooth, dinosaur bones (Ornithischia), starfish (Asteroidea), molluscs, plants fossils.

Appendix G
Water Resources

Water Resources – Tables

Table G-1. Average Monthly Air Temperatures at Barter Island, Toolik Lake, and Kuparuk

Barter Island STA: Avg. Monthly Temp. (°F)			Toolik Lake STA: Avg. Monthly Temp. (°F)	
Month	2015-		2017	2018
Jan	no data		no data	no data
Feb	no data		no data	9.2
Mar	no data		no data	8.1
Apr	no data		no data	9.7
May	no data		no data	29.1
Jun	no data		no data	41.6
Jul	no data		no data	no data
Aug	no data		no data	no data
Sep	no data		32.7	no data
Oct	5.2		17	no data
Nov	no data		8.9	no data
Dec	no data		10.3	no data

Adapted from *Global Summary of the Month Station Details* by the National Centers for Environmental Information: https://www.ncdc.noaa.gov/cdo-web/datatools/findstation

Table G-1 cont. Average Monthly Air Temperatures at Barter Island, Kuparuk, and Toolik Lake

Kuparuk STA: Avg. Monthly Air Temp. (°F)																		
Month	Years																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	-14.4	-11.8	-20.6	-12	-14	-11	-16	-18	-21	-18	-19	-14	23.8	22.5	7.4	0.9	8.6	10.7
Feb	-16.7	-5.7	-22.6	-17	-29	-17	-6.6	-14	-19	-17	-13	-9.5	1	2.3	-10	-16	-8.2	3.9
Mar	-15.5	-19.7	-4.8	-14	-20	-9.3	-19	-21	-21	-22	-13	-8.9	-18	-10	-13	-4.5	-6	-9.3
Apr	-1.8	0.8	3.3	7.1	-1	1.1	-4.5	7.6	9.2	3.6	11	-2.5	-18	-14	-6.3	-5.4	-12	0.8
May	15.3	12.4	27.9	23.8	23.8	23.3	26.2	18.5	27.1	26.7	21.7	23.1	-25	-8.2	-9.8	-7.4	-9.3	-2.2
Jun	43.9	39.2	39.3	37.7	44.7	37.5	46.6	39.6	44.6	39	38.3	-26	-11	4.2	7.6	10.5	4.5	3.6
Jul	46	47.1	45.2	48.5	49.4	40.4	47.6	46.8	49.7	47.5	49.2	-14	-2.9	29.2	31	30.1	25.8	21.2
Aug	41.8	41.5	43.4	40.6	48.1	44.8	40.2	45.8	41.3	45.3	47.4	-29	20.6	38.5	48.1	43.6	38.8	34.5
Sep	32.8	35.1	38.9	33.1	33.8	34.9	39.7	38	34	34.8	37.5	2.2	44.1	45.3	44.4	49.2	52.2	no data
Oct	14.5	8.6	20.2	23.9	18.8	19.2	24.9	19.2	16.9	25	22.2	22	49.3	42.4	41.1	45.4	45.1	no data
Nov	-2.3	-2.4	7.1	-0.3	-1.4	-13	-1	10.7	0.9	-3.2	12.1	41.8	45.8	34.2	30.3	35.3	36.8	no data
Dec	-7.2	-11.8	-3.8	-9.8	-12	-5.9	-4.3	-4.5	-3.1	-3.4	-17	51.4	31.9	22.1	20.3	24.9	21.3	no data

Adapted from *Global Summary of the Month Station Details* by the National Centers for Environmental Information: https://www.ncdc.noaa.gov/cdo-web/datatools/findstation

Table G-2. Average Monthly Precipitation at Toolik Lake and Kuparuk

Toolik Lake STA: Avg. Monthly Precipitation (in)		
Month	Years	
	2017	2018
Jan	no data	0.12
Feb	no data	0.44
Mar	no data	0.2
Apr	no data	0.06
May	no data	0.9
Jun	no data	1.45
Jul	no data	no data
Aug	no data	no data
Sep	0.69	no data
Oct	0.81	no data
Nov	0.62	no data
Dec	0.12	no data

Adapted from *Normals Annual/Seasonal Station Details* by the National Centers for Environmental Information: https://www.ncdc.noaa.gov/cdo-web/datatools/findstation

Table G-2 cont. Average Monthly Precipitation at Toolik Lake and Kuparuk

Kuparuk: Avg. Monthly Precipitation (in)																		
Month	Years																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	0.09	0.01	0.21	0.09	0.01	0.2	0.19	0.45	0.04	0	0.21	0.22	1.02	0.29	0.5	0.27	0.81	0.83
Feb	0.12	0	0.15	0.13	0.3	0.09	0.11	0.02	0.19	0.17	0.11	0.26	0.36	0.41	0.76	0.05	0.13	0.74
Mar	0.06	0	0.12	0.02	0.3	0.03	0.01	0.06	0.08	0	0.21	0.03	0.15	0.04	0.16	0.21	0.39	0.23
Apr	0.07	0.01	0.14	0.18	0.04	0.05	0.31	0.14	0.09	0.2	0.12	0.07	0.02	0.12	0.3	0.08	0.52	0.37
May	0	0.03	0	0.19	0	0.14	0.04	0.29	0.56	0.04	0.08	0.51	0.02	0.01	0.15	0.2	0.09	0.11
Jun	0.16	0.35	1.05	0.01	0.4	0.01	0.78	0.22	0.43	0	0.05	0.17	0.2	0.09	0.31	0.1	0.11	0.12
Jul	1.12	0.26	1.1	2.22	1.02	1.06	1.67	0.22	1.07	0.45	1.22	0.07	0.91	0.76	0.09	0.11	0.18	0.25
Aug	0.38	1.35	1.93	0.67	0.61	0.5	1.07	0.11	0.62	2.13	0.4	0.1	0.43	0.49	0.14	1.1	0.01	0.3
Sep	0.14	0.25	1.67	0.4	0.97	0.62	0.12	0.01	0.2	0.67	0	0.12	0.31	1.09	0.28	0.81	0.67	no data
Oct	0.13	0.28	0.46	0.87	0.5	0.21	0.35	0.15	0.52	0.33	0.34	0.09	1.77	0.44	2.58	1.63	2.16	no data
Nov	0.03	0.17	0.04	0.11	0.16	0.5	0.23	0.4	0.29	0.11	0.56	0.03	0.89	0.5	0.33	1.63	1.02	no data
Dec	0.05	0.08	0.44	0.14	0.28	0.25	0.27	0.09	0.19	0.15	0.17	0.1	1.02	1.42	0.22	0.28	0.87	no data

Adapted from *Normals Annual/Seasonal Station Details* by the National Centers for Environmental Information: https://www.ncdc.noaa.gov/cdo-web/datatools/findstation

Table G-3. Average Monthly Snowfall at Kuparuk

Adapted from *Normals Annual/Seasonal Station Details* by the National Centers for Environmental Information: https://www.ncdc.noaa.gov/cdo-web/datatools/findstation

Kuparuk: Avg Monthly Snowfall (in)																		
Month	Years																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	4.1	0.6	4	2.4	0.2	3.5	4.3	5.3	1	0.4	7.4	0.6	7.1	5.2	5.1	4.5	17.2	11.2
Feb	5.5	1	1.4	4.8	2.7	2	2.6	0.5	3.4	5.4	3	1.9	3.5	5.2	11.7	1.7	2.5	5.2
Mar	3.3	0.9	1	2.1	5.1	1	0.8	1.2	2.6	0	4.8	0.8	1.7	1	4.1	3.9	1.8	5.2
Apr	4	1.2	1.8	4	1.5	1.3	5.5	3.9	7.2	2.7	2.6	1.9	0.9	2	3.3	1.1	6.3	6.3
May	2	7.4	0	6.5	0	3.7	0.8	10.3	0.8	1.6	0.3	1.3	1	1.5	3.4	5	3.3	1.5
Jun	0	0	1.8	0	0	0.2	0.3	0	0	0	0.3	2.2	4	4.1	10.2	1.3	2.9	0.9
Jul	0	0	0	0	0	0	0	0	0	0	0	1.4	8.9	4.4	0.2	0	0.8	4.3
Aug	1.7	0.1	0	0	0	0	0	0	0	0	0	1.3	4.7	1.4	1	2.5	0	0
Sep	1.5	1.9	3.4	2.8	4.4	0.3	0	0	0.5	3.5	0	3		0	0	0	0	no data
Oct	5.5	7.5	15.3	7.9	8	4.7	6.5	5.1	17.3	6.9	9.3	1.6	0	0	0	0	0	no data
Nov	0.7	7.1	2.7	3.3	2	10.2	4.8	15.1	7.5	4.4	13.5	0	0	0.6	3.1	0.2	0	no data
Dec	1.1	4.2	9.3	5.4	2.7	5.3	5.5	3.7	4.3	4.2	4.4	0	6	7	2.8	1.1	3	no data

Table G-4. Summary of Drainage Basins and Streams in the Coastal Plain

Drainage Basin	Waterbodies (notable streams)	Headwater Origin	Receiving Water	Drainage Area (square mi)
Akutoktak (Akootoaktuk) River	None	Romanzof Mountains	Okpilak River	97
Angun River	None		Angun Lagoon, Arctic Ocean	
Atigun River	Sagavanirktok River	Endicott Mountains	Ribdon River	48.7
Hulahula River	None	Romanzof Mountains	Camden Bay	
Itkilyariak Creek, West Fork	Itkilyariak Creek, Salderochit River	Sadlerochit Mountains	Camden Bay	27
Kongakut River	Siku Lagoon	Davidson Mountains	Beaufort Sea	
Marsh Fork-Canning River	Canning River	Philip Smith Mountains	Canning River	
Niguanak River	None	Tundra drainage	Oruktalik Lagoon	136
Sadlerochit River	Peters River	Franklin Mountains, Brooks Range	Camden Bay	520
Sadlerochit Spring Creek	Itkilyariak Creek, Salderochit River	Eastern Sadlerochit Mountains	Camden Bay	0.5
Sagavanirktok River	None	Brooks Range; between Endicott and Philip Smith Mts.	Beaufort Sea	1860 e
Sikrelurak River	None	Tundra drainage	West Fork Sikrelurak River	75
Tamayariak River	Upper Main Stem, Lower West Fork, Middle Fork, and Upper West Fork of Tamayariak River, Canning River	Sadlerochit Mountains	Beaufort Sea	350

Note: e = estimate

Adapted from *Water Resource Inventory and Assessment* by the U.S. Dept. of the Interior (1987-1992, Table 2), https://www.fws.gov/alaska/water/arctic.htm, and https://alaska.guide/Rivers

Table G-5. Stream Lengths of Major Streams in the Coastal Plain

Stream Name	Length (mi)
Akutoktak River	11.8
Angun River	16.3
Atigun River	45
Carter Creek	21.9
Igilatvik Creek	20.1
Itkilyariak Creek	14.8
John River	4.5
Kajutakrok Creek	9.4
Katakturuk River	1.9
Kimikpaurauk River	5.2
Kogotpak River	19.5
Marsh Creek	20.3
Nataroarok Creek	21.1
Niguanak River	14.1
Nularvik River	1.0
Okerokovik River	3.8
Okpirourak Creek	19.9
Pokok Creek	1.0
Sadlerochit River	0.2
Sikrelurak River	18.5
Siksik River	7.4
Staines River	17.6
Tamayariak River	19.3
West Fork Marsh Creek	7.3

Recreated from *National Hydrography Dataset: flowlines GIS data*. by the U.S. Geological Survey and https://alaska.guide/Rivers

Table G-6. Water Discharge during Peak Spring Breakup and Totals

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Akutoktak River																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	8400	280	1000	20	318	10	20	5.9	1023	33	111	5.5	11619	89	6.03	119 e	8/23/1988	23046	0.91	4.45
Oct 1988 – Sep 1989	8862	295	1020	10	3231	129	719	2.4	2576	-	608	66	14669	233	3.57	1703	8/20/1989	29096	2.4	5.62
Oct 1989 – Sep 1990	802	27	134	6.9	80	3	8	1.0	94	3	11	0.80	4767	38	0.93	215	6/20/1990	9454	0.39	1.83
Oct 1990 – Sep 1991	7657	255	1230	31	1389	45	314	3.1	1118	36	100	11	14478	111	3.77	768	6/14/1991	28717	1.14	5.55
Oct 1991 – Sep 1992	5403	180	630	11	322	10	29	4.3	3240	105	943	7.5	12202	104	5.57	1818	8/27/1992	24202	1.07	4.67

Note: e = estimate

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Itkilyariak Creek, West Fork																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct 1988 – Sep 1989	1253	42	90	4.9	1506	49	320	0.0	3145	101	554	25.0	7012	59	1.88	1419	8/20/1989	13909	2.19	9.69
Oct 1989 – Sep 1990	890	30	89	4.9	237	7.6	49	0.0	155	5.0	21	1.2	7019	54	0.53	160	6/19/1990	13921	2.01	9.70
Oct 1990 – Sep 1991	6046	202	1120	37	239	11	37	6.0	710	25	173	4.1	9894	85	2.89	276	6/14/1991	19624	3.14	13.68
Oct 1991 – Sep 1992	2325	78	710	7.7	121	-	24	15	1682	80	679	3.7	7431	91	-	1255	8/27/1992	14740	3.37	10.27

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Niguanak River (in cubic ft/sec unless noted otherwise)																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct 1988 – Sep 1989	15548	518	1360	53	2352	76	311	18	5984	193	1148	50	30588	259	39.50	2071	8/21/1989	60670	1.90	8.35
Oct 1989 – Sep 1990	1949	65	138	26	136	-	21	0.7	16	-	1	0.0	14707	111	0.00	-	-	29170	0.82	4.02
Oct 1990 – Sep 1991	21471	716	2000	215	3802	123	515	41	678	22	52	9.3	36904	282	4.11	1319	6/14/1991	73199	2.07	10.08
Oct 1991 – Sep 1992	9623	321	1109	90	859	-	203	92	-	-	-	-	-	-	-	-	-	-	-	-

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Sadlerochit River																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	-	-	-	-	3856	-	846	342	17052	-	1937	695	28224	-	92.91	2194	8/22/1988	-	-	-
Oct 1988 – Sep 1989	21169	-	3315	923	51833	1672	4124	649	49581	159	4385	572	137116	1414	313.63	5733	8/4/1989	271966	2.72	9.80
Oct 1989 – Sep 1990	26668	1333	2678	177	29232	943	1429	633	13381	432	662	271	70795	833	333.05	4857	6/18/1990	140419	1.60	5.06
Oct 1990 – Sep 1991	48412	1793	3715	365	27665	1317	9190	399	18684	692	1732	380	102417	1035	122.67	21000	7/21/1991	203142	1.99	7.32
Oct 1991 – Sep 1992	46901	1563	2614	123	51762	1670	5656	625	32067	1034	4216	362	141366	1240	88.97	9506	7/26/1992	280395	2.38	10.11

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Sadlerochit Spring Creek																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	1125	38	40	33	1210	39	40	37	1264	41	44	37	13005	36	28	55	8/16/1988 8/19/1988	25795	-	967
Oct 1988 – Sep 1989	1121	37	42	32	1348	43	52	38	1809	58	81	46	14789	41	28	108	8/20/1989	29334	-	1100
Oct 1989 – Sep 1990	1172	39	40	36	1152	37	40	36	1110	36	36	35	13524	37	28	41	8/18/1990 8/19/1990	26825	-	1006
Oct 1990 – Sep 1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct 1991 – Sep 1992	1133	38	40	36	1298	42	45	40	1408	45	51	45	13146	36	28	61	8/27/1992	26075	-	978

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Sikrelurak River																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct 1988 – Sep 1989	10065	336	1220	16	575	19	72	1.7	1927	62	235	13	14378	126	4.38	282	8/20/1989	28518	1.69	7.16
Oct 1989 – Sep 1990	665	22	47	11	70	2.2	9.2	1.7	8.4	0.3	1.5	0.0	5236	42	0.00	117	9/7/1990	10386	0.56	2.61
Oct 1990 – Sep 1991	9302	310	1480	44	1012	33	118	13	344	11	28	4.6	14119	108	3.14	1787	6/4/1991	28004	1.44	7.03
Oct 1991 – Sep 1992	6888	767	930	15	195	6	26	1.3	34	1.4	2.0	1.3	9909	99	1.35	1057	6/10/1992	19654	1.33	4.93

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Tamayariak River																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	16900	563	1400	160	2166	70	140	18	9687	312	1039	120	34549	279	21.07	1996	8/12/1988	68526	2.05	9.44
Oct 1988 – Sep 1989	20870	696	2140	114	7502	242	823	53	10482	338	778	138	43646	383	93.54	997	7/17/1989	86571	2.81	11.93
Oct 1989 – Sep 1990	5915	197	794	88	1731	56	146	30	3596	116	1100	21	32644	247	23.57	4099	9/6/1990	64748	1.82	8.92
Oct 1990 – Sep 1991	20442	681	2000	139	8925	288	1400	66	7250	279	2442	72	49876	381	62.13	3244	8/22/1991	98928	2.80	13.63
Oct 1991 – Sep 1992	11543	385	1032	109	2007	65	154	32	0.48	1777	68	25	19947	217	27.69	2856	8/27/1992	39564	1.59	5.45

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Tamayariak River, Lower West Fork																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	12100	403	1380	50	616	20	40	11	3525	114	392	9.4	19220	155	10.17	496	9/5/1988	38123	1.58	7.28
Oct 1988 – Sep 1989	15735	525	1880	10	2230	115	345	43	4748	153	477	44	24807	221	25.14	647	8/21/1989	49204	2.26	9.40
Oct 1989 – Sep 1990	1276	43	110	20	352	11	20	6.1	118	3.8	6.1	2.2	16628	133	2.41	2455	9/6/1990	32981	1.36	6.30
Oct 1990 – Sep 1991	14800	493	2050	135	3997	129	960	24	1547	50	241	19	27048	206	21.50	1750	7/23/1991	53649	2.10	10.25
Oct 1991 – Sep 1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Tamayariak River, Middle Fork																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	11520	384	1300	50	268	8.6	40	2.2	3089	100	351	1.4	17235	139	2.02	618	9/5/1988	34185	2.27	10.46
Oct 1988 – Sep 1989	13610	454	1780	26	2168	70	255	14	3928	127	282	43	21623	193	18.87	303	8/21/1989	42889	3.15	13.12
Oct 1989 – Sep 1990	1170	39	151	12	108	3.5	11	0.82	24	0.78	4.7	0.41	9158	69	0.46	637	9/6/1990	18165	1.13	5.56
Oct 1990 – Sep 1991	11198	373	1580	38	2795	90	800	14	1048	34	225	6.9	18910	144	6.11	1867	6/4/1991	37507	2.35	11.47
Oct 1991 – Sep 1992	2712	90	470	12	114	3.7	17	0.80	2004	65	1026	0.60	8079	73	0.71	1455	8/27/1992	16024	1.19	4.90

Adapted from Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992): Appendix A by the U.S. Fish and Wildlife Service

Table G-6 cont. Water Discharge during Peak Spring Breakup and Totals

Tamayariak River, Upper West Fork																				
	Jun				Jul				Aug				Totals							
	(cubic ft/sec)												(cubic ft/sec)					(ac-ft)	(CFSM)	(in)
Years	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean	Max	Min	Total	Mean 9/19 - 9/26)	Seven-Day Low Flow	Instantaneous Peak Flow (IPF)	IPF Date	Total Runoff	Average Runoff	Total Runoff
Oct 1987 – Sep 1988	13160	439	1490	60	291	9.4	50	0.8	2636	85	271	1.1	17916	144	0.92	404	8/13/1988	35536	2.94	13.54
Oct 1988 – Sep 1989	12529	418	2050	24	1699	55	220	3.4	3920	126	530	37	19554	175	10.89	1478	8/20/1989	38785	3.55	14.78
Oct 1989 – Sep 1990	769	26	130	6.0	60	1.9	6.2	0.00	541	17	323	0.00	9880	79	0.00	1328	9/6/1990	19597	1.61	7.47
Oct 1990 – Sep 1991	10497	350	1820	82	3071	99	681	9.1	1171	38	202	6.3	19055	145	2.70	1219	8/22/1991	37794	2.96	14.40
Oct 1991 – Sep 1992	4625	154	890	6.6	333	11	40	4.0	19.1	0.73	4.0	0.00	8088	89	0.00	996	6/10/1992	16042	1.81	6.11

Adapted from *Water Resource Inventory and Assessment Arctic National Wildlife Refuge (1987-1992)*: Appendix A by the U.S. Fish and Wildlife Service

Table G-7. Summary of Data for Lakes in Regions of the Plan Area

		0 ft Ice		4 ft Ice (Jan 4)		7 ft Ice (Apr 16)	
Region	**No. Lakes**	**Volume (acre-ft)**	**Percent of Total (%)**	**Volume (acre-ft)**	**Percent of Total (%)**	**Volume (acre-ft)**	**Percent of Total (%)**
Canning	43	35,541	64.2	12,378	69.7	2,669	79.3
Katakturuk	2	339	0.6	93	0.5	6	0.2
Sadlerochit	34	9,959	18.0	2,504	14.1	186	5.5
Jago	40	9,543	17.2	2,783	15.7	505	15.0
Totals	119	55,382	100.0	17,758	100.0	3,366	100.0

Recreated from *Distribution and quantification of water within the lakes of the 1002 Area, Arctic National Wildlife Refuge, Alaska*: Table 1. by the U.S. Fish and Wildlife Service

Appendix H

Vegetation and Wetlands, Birds, and Terrestrial Mammals

TABLE OF CONTENTS

Section Page

Appendix H. Vegetation and Wetlands, Birds, and Terrestrial Mammals

BIRDS

Table H-1
Status, abundance, and conservation listings of bird species occurring on the Coastal Plain of the Arctic National Wildlife Refuge.

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Waterbirds						
Greater White-fronted Goose	*Anser albifrons*	Breeder: uncommon Migrant: common (spring, fall)				
Snow Goose	*Anser caerulescens*	Visitor: rare (summer) Migrant: common (spring), abundant (fall)				
Ross's Goose	*Anser rossii*	Migrant: casual (spring), possible (fall)				
Brant	*Branta bernicla*	Breeder: uncommon Migrant: common (coast)				
Cackling Goose	*Branta hutchinsii*	Breeder: common Migrant: common (spring, fall)				
Trumpeter Swan	*Cygnus buccinator*	Breeder and Visitor: casual			S	
Tundra Swan	*Cygnus columbianus*	Breeder: common				
Northern Shoveler	*Spatula clypeata*	Possible Breeder: uncommon Visitor: uncommon				
Gadwall	*Mareca strepera*	Visitor: casual				
Eurasian Wigeon	*Mareca penelope*	Visitor: casual				
American Wigeon	*Mareca americana*	Migrant: uncommon				
Mallard	*Anas platyrhynchos*	Breeder: rare (inland), uncommon (rest of coastal plain)				
Northern Pintail	*Anas acuta*	Breeder and Migrant: common				
Green-winged Teal	*Anas crecca*	Breeder: uncommon (inland), rare (coast) Migrant: rare (coast)				
Canvasback	*Aythya valisineria*	Visitor: casual				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Greater Scaup	*Aythya marila*	Breeder: rare (inland) Visitor: uncommon (coast) Migrant: uncommon (coast)				
Lesser Scaup	*Aythya affinis*	Breeder: rare (inland) Visitor: rare (inland)				
Steller's Eider	*Polysticta stelleri*	Visitor: rare (coast)	Threatened			A
Spectacled Eider	*Somateria fischeri*	Breeder: rare (coast) Visitor: uncommon (coast)	Threatened			A
King Eider	*Somateria spectabilis*	Breeder: fairly common (coast) Migrant: uncommon (coast)				
Common Eider	*Somateria mollissima*	Breeder: common (barrier islands) Migrant: common (coast)				
Harlequin Duck	*Histrionicus histrionicus*	Breeder: rare (inland)				
Surf Scoter	*Melanitta perspicillata*	Possible Breeder: uncommon (inland) Migrant: uncommon (coast)				
White-winged Scoter	*Melanitta fusca*	Possible Breeder: rare (inland) Migrant: common (coast)				
Black Scoter	*Melanitta americana*	Migrant: uncommon (coast)				A
Long-tailed Duck	*Clangula hyemalis*	Breeder: common Migrant: abundant (coast) in fall				
Common Goldeneye	*Bucephala clangula*	Visitor: rare				
Smew	*Mergellus albellus*	Visitor: accidental				
Common Merganser	*Mergus merganser*	Visitor: casual (inland)				
Red-breasted Merganser	*Mergus serrator*	Breeder: fairly common (inland), rare (coast) Migrant: fairly common (coast)				
Horned Grebe	*Podiceps auritus*	Possible Breeder: uncommon (inland) Visitor: casual				
Red-necked Grebe	*Podiceps grisegena*	Visitor: casual				
Sandhill Crane	*Antigone canadensis*	Breeder: rare Summer Resident: uncommon				
Red-throated Loon	*Gavia stellata*	Breeder: fairly common (coast) Migrant: fairly common (coast)		C	S	A
Pacific Loon	*Gavia pacifica*	Breeder: common Migrant: common (coast)				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Common Loon	*Gavia immer*	Visitor: rare (coast)				
Yellow-billed Loon	*Gavia adamsii*	Migrant: uncommon (coast), rare (inland)		C	S	A
Shorebirds						
Black-bellied Plover	*Pluvialis squatarola*	Breeder: rare Migrant: rare (coast) to fairly common (coast in fall)				
American Golden-Plover	*Pluvialis dominica*	Breeder: common				A
Semipalmated Plover	*Charadrius semipalmatus*	Breeder: uncommon (barrier islands) and fairly common (inland) Visitor: rare				
Killdeer	*Charadrius vociferus*	Visitor: casual				
Eurasian Dotterel	*Charadrius morinellus*	Visitor: casual				
Upland Sandpiper	*Bartramia longicauda*	Breeder: fairly common (inland)				A
Whimbrel	*Numenius phaeopus*	Breeder: rare (inland) Visitor: uncommon (coast)		C	S	A
Black-tailed Godwit	*Limosa limosa*	Visitor: accidental				
Hudsonian Godwit	*Limosa haemastica*	Visitor: casual		C[f]	S	A
Bar-tailed Godwit	*Limosa lapponica*	Possible Breeder: uncommon		C	S	A
Ruddy Turnstone	*Arenaria interpres*	Breeder: fairly common (coast), uncommon (inland)				
Red Knot	*Calidris canutus*	Migrant: rare		C	S	A
Ruff	*Calidris pugnaC*	Visitor: casual				
Sharp-tailed Sandpiper	*Calidris acuminata*	Migrant: casual (coast)				
Stilt Sandpiper	*Calidris himantopus*	Breeder: uncommon Migrant: uncommon (fall)				
Red-necked Stint	*Calidris ruficollis*	Visitor: casual (coast)				
Sanderling	*Calidris alba*	Breeder: rare Migrant: rare (coast in spring), uncommon (coast in fall)				A
Dunlin	*Calidris alpina*	Breeder: uncommon (coast) Migrant: uncommon (coast in fall)		C	S	A
Baird's Sandpiper	*Calidris bairdii*	Breeder: uncommon				
Least Sandpiper	*Calidris minutilla*	Visitor: rare				
White-rumped Sandpiper	*Calidris fuscicollis*	Breeder: rare Migrant: rare (spring), uncommon (fall)				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Buff-breasted Sandpiper	*Calidris subruficollis*	Breeder: uncommon Migrant: uncommon		C	S	A
Pectoral Sandpiper	*Calidris melanotos*	Breeder: abundant Migrant: abundant (coast in fall)				A
Semipalmated Sandpiper	*Calidris pusilla*	Breeder: abundant (coast), common (inland) Migrant: common (coast in fall)				A
Western Sandpiper	*Calidris mauri*	Possible Breeder: rare, Migrant: uncommon on coast				A
Long-billed Dowitcher	*Limnodromus scolopaceus*	Breeder: uncommon, Visitor: fairly common (summer), Migrant: common on coast				
Wilson's Snipe	*Gallinago delicata*	Possible Breeder and Visitor: rare				
Spotted Sandpiper	*Actitis macularius*	Breeder: uncommon (inland)				
Wandering Tattler	*Tringa incana*	Breeder: uncommon (inland)				
Lesser Yellowlegs	*Tringa flavipes*	Visitor: casual		C[g]		A
Wilson's Phalarope	*Phalaropus tricolor*	Visitor: accidental				
Red-necked Phalarope	*Phalaropus lobatus*	Breeder: common Migrant: common to abundant (coast)				
Red Phalarope	*Phalaropus fulicarius*	Breeder: fairly common (coast east to Jago delta), uncommon (rest of coastal plain) Migrant: uncommon (coast in fall)				
Larids						
Pomarine Jaeger	*Stercorarius pomarinus*	Breeder: occasionally common (coast) Visitor: common (summer) Migrant: common (spring)				
Parasitic Jaeger	*Stercorarius parasiticus*	Breeder: uncommon Summer Resident: common				
Long-tailed Jaeger	*Stercorarius longicaudus*	Breeder: fairly common (inland), rare (coast) Summer Resident: common				
Black-legged Kittiwake	*Rissa tridactyla*	Visitor: rare (coast mostly offshore)				
Ivory Gull	*Pagophila eburnea*	Migrant: rare				
Sabine's Gull	*Xema sabini*	Breeder: uncommon (coast) Migrant: uncommon (coast)				
Bonaparte's Gull	*Chroicocephalus philadelphia*	Visitor: casual				
Ross's Gull	*Rhodostethia rosea*	Migrant: rare (coast)				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Mew Gull	*Larus canus*	Breeder and Visitor: rare				
Herring Gull	*Larus argentatus*	Visitor and Migrant: rare				
Thayer's Gull	*Larus thayeri*	Visitor: rare				
Slaty-backed Gull	*Larus schistisagus*	Visitor: casual (coast)				
Glaucous-winged Gull	*Larus glaucescens*	Visitor: casual (coast)				
Glaucous Gull	*Larus hyperboreus*	Breeder: common (coast), uncommon (inland) Summer Resident: adundant (coast)				
Caspian Tern	*Hydroprogne caspia*	Visitor: accidental				
Arctic Tern	*Sterna paradisaea*	Breeder: uncommon (coast), rare (inland) Summer Resident: common		C		
Raptors and Owls						
Osprey	*Pandion haliaetus*	Visitor: accidental				
Bald Eagle	*Haliaeetus leucocephalus*	Visitor: casual				
Northern Harrier	*Circus hudsonius*	Possible Breeder: uncommon (inland) Summer Resident: uncommon				A
Sharp-shinned Hawk	*Accipiter striatus*	Visitor: casual				
Northern Goshawk	*Accipiter gentilis*	Visitor: casual (inland)				
Rough-legged Hawk	*Buteo lagopus*	Breeder: uncommon (inland) Visitor: rare (coast)				
Golden Eagle	*Aquila chrysaetos*	Breeder: rare (inland) Visitor: fairly common				A
Snowy Owl	*Bubo scandiacus*	Breeder: common (in high microtine rodent years) to rare				A
Short-eared Owl	*Asio flammeus*	Breeder: common (in high microtine rodent years) to uncommon				A
American Kestrel	*Falco sparverius*	Visitor: casual				A
Merlin	*Falco columbarius*	Possible Breeder and Visitor: rare				
Gyrfalcon	*Falco rusticolus*	Permanent Resident and Breeder: uncommon (inland) Visitor: rare on coast				A
Peregrine Falcon	*Falco peregrinus*	Breeder: rare Visitor: uncommon				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Landbirds						
Willow Ptarmigan	*Lagopus lagopus*	Permanent Resident and Breeder: uncommon (coast), common to abundant (inland)				
Rock Ptarmigan	*Lagopus muta*	Permanent Resident and Breeder: common				
Common Nighthawk	*Chordeiles minor*	Visitor: casual				
Rufous Hummingbird	*Selasphorus rufus*	Visitor: accidental				A
Belted Kingfisher	*Megaceryle alcyon*	Visitor: casual				A
Hammond's Flycatcher	*Empidonax hammondii*	Visitor: accidental				
Eastern Phoebe	*Sayornis phoebe*	Visitor: accidental				
Say's Phoebe	*Sayornis saya*	Visitor: rare				
Eastern Kingbird	*Tyrannus tyrannus*	Visitor: accidental				
Northern Shrike	*Lanius borealis*	Possible Breeder and Visitor: rare (inland)				
Gray Jay	*Perisoreus canadensis*	Visitor: casual				
Common Raven	*Corvus corax*	Permanent Resident: uncommon Possible Breeder: rare				
Horned Lark	*Eremophila alpestris*	Breeder: rare (inland) Visitor: rare (rest of coastal plain)				A
Tree Swallow	*Tachycineta bicolor*	Visitor: casual				A
Violet-green Swallow	*Tachycineta thalassina*	Visitor: casual				
Bank Swallow	*Riparia riparia*	Visitor: casual				A
Cliff Swallow	*Petrochelidon pyrrhonota*	Possible Breeder and Visitor: rare				
Barn Swallow	*Hirundo rustica*	Visitor: casual				A
American Dipper	*Cinclus mexicanus*	Permanent Resident and Breeder: uncommon (inland)				
Bluethroat	*Luscinia svecica*	Breeder: rare (inland)				
Northern Wheatear	*Oenanthe oenanthe*	Visitor: rare				
Gray-cheeked Thrush	*Catharus minimus*	Visitor: rare				
Hermit Thrush	*Catharus guttatus*	Visitor: accidental				
American Robin	*Turdus migratorius*	Breeder: uncommon (inland) Visitor: rare (coast)				
Varied Thrush	*Ixoreus naevius*	Visitor: casual				A
Cedar Waxwing	*Bombycilla cedrorum*	Visitor: accidental				
Eastern Yellow Wagtail	*Motacilla tschutschensis*	Breeder: fairly common				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
American Pipit	*Anthus rubescens*	Breeder: rare Migrant: uncommon (fall)				A
Common Redpoll	*Acanthis flammea*	Breeder: common				A
Hoary Redpoll	*Acanthis hornemanni*	Breeder: common				
Pine Siskin	*Spinus pinus*	Visitor: casual				A
Lapland Longspur	*Calcarius lapponicus*	Breeder: abundant				
Smith's Longspur	*Calcarius pictus*	Visitor: rare		C	S	A
Snow Bunting	*Plectrophenax nivalis*	Breeder: common (coast)				A
Northern Waterthrush	*Parkesia noveboracensis*	Visitor: casual				
Orange-crowned Warbler	*Oreothlypis celata*	Visitor: casual				A
Yellow Warbler	*Setophaga petechia*	Breeder: rare (inland) Visitor: rare (coast)				A
Yellow-rumped Warbler	*Setophaga coronata*	Visitor: casual				
Wilson's Warbler	*Cardellina pusilla*	Visitor: rare				A
American Tree Sparrow	*Spizelloides arborea*	Breeder: common (inland): Visitor: rare (coast)				
Chipping Sparrow	*Spizella passerina*	Visitor: casual				A
Clay-colored Sparrow	*Spizella pallida*	Visitor: accidental				
Savannah Sparrow	*Passerculus sandwichensis*	Breeder: common				A
Fox Sparrow	*Passerella iliaca*	Breeder: rare (inland) Visitor: rare (coast)				A
White-throated Sparrow	*Zonotrichia albicollis*	Visitor: casual				
White-crowned Sparrow	*Zonotrichia leucophrys*	Breeder: uncommon (inland) Visitor: rare (coast)				A
Dark-eyed Junco	*Junco hyemalis*	Visitor: rare				
Red-winged Blackbird	*Agelaius phoeniceus*	Visitor: casual				A
Rusty Blackbird	*Euphagus carolinus*	Visitor: casual				
Brown-headed Cowbird	*Molothrus ater*	Visitor: casual				
Seabirds						
Thick-billed Murre	*Uria lomvia*	Migrant: rare (coast)				
Black Guillemot	*Cepphus grylle*	Breeder: rare (coast) Summer Resident: uncommon (coast)				
Least Auklet	*Aethia pusilla*	Visitor: casual (coast)				
Horned Puffin	*Fratercula corniculata*	Visitor: rare (coast)				

Species Group/ Common Name	Scientific Name	Status and Abundance[a]	Conservation Listings			
			ESA[b]	USFWS BCC[c]	BLM[d]	ADFG[e]
Tufted Puffin	*Fratercula cirrhata*	Visitor: casual (coast)				
Northern Fulmar	*Fulmarus glacialis*	Visitor: rare (offshore)				
Short-tailed Shearwater	*Ardenna tenuirostris*	Visitor: rare (coast mostly offshore)				

[a] Status and abundance from the bird occurrence information for the Arctic Refuge Coastal Plain presented in USFWS (2015b).
[b] Endangered Species Act listings for Alaska (USFWS and NMFS 2014).
[c] C = Bird of Conservation Concern from USFWS (2008).
[d] S = Sensitive Species from BLM (2018).
[e] A = At-risk Species from ADFG (2015).
[f] Listed as a species of conservation concern for Bird Conservation Regions 2 and 5 only.
[g] Listed as a species of conservation concern for Bird Conservation Regions 4 and 5 only.

TERRESTRIAL MAMMALS

Table H-2
Terrestrial mammal species known or suspected to occur in the Arctic National Wildlife Refuge (adapted from Appendix F in USFWS 2015).

English Name[a]	Scientific Name[a]	Present in Coastal Plain Program Area
Cinereus shrew	*Sorex cinereus*	No
Pygmy shrew	*Sorex hoyi*	No
Dusky shrew	*Sorex monticolus*	No
Tundra shrew	*Sorex tundrensis*	Yes
Barren ground shrew	*Sorex ugyunak*	Yes
Holarctic least shrew	*Sorex minutissimus*	Yes
Collared lemming	*Dicrostonyx groenlandicus*	Yes
Brown lemming	*Lemmus trimucronatus*	Yes
Long-tailed vole	*Microtus longicaudus*	No
Singing vole	*Microtus miurus*	Yes
Root (tundra) vole	*Microtus oeconomus*	Yes
Meadow vole	*Microtus pennsylvanicus*	No
Taiga vole	*Microtus xanthognathus*	No
Northern red-backed vole	*Myodes rutilus*	No
Common muskrat	*Ondatra zibethicus*	No
Northern bog lemming	*Synaptomys borealis*	No
Alaska marmot	*Marmota broweri*	No
Arctic ground squirrel	*Urocitellus parryii*	Yes
Red squirrel	*Tamiasciurus hudsonicus*	No
North American porcupine	*Erethizon dorsatum*	No
American beaver	*Castor canadensis*	No; range is expanding northward
Snowshoe hare	*Lepus americanus*	Rare; range is expanding northward
Wolverine	*Gulo gulo*	Yes
North American river otter	*Lontra canadensis*	Rare
American marten	*Martes americana*	No
Ermine	*Mustela erminea*	Yes
Least weasel	*Mustela nivalis*	Yes
American mink	*Neovison vison*	No
Canada lynx	*Lynx canadensis*	Rare
Wolf	*Canis lupus*	Yes
Coyote	*Canis latrans*	Rare
Arctic fox	*Vulpes lagopus*	Yes
Red Fox	*Vulpes vulpes*	Yes
American black bear	*Ursus americanus*	No
Brown (grizzly) bear	*Ursus arctos*	Yes
Moose	*Alces americanus*	Yes
Caribou	*Rangifer tarandus*	Yes
Dall's sheep	*Ovis dalli*	No; nearby in mountains to south
Muskox	*Ovibos moschatus*	Yes

[a] Sources: MacDonald and Cook (2009), with taxonomic and nomenclatural updates from Bradley et al. (2014).

Table H-3

Acres (1000s) of different land cover types (Boggs et al. 2016) by different lease restriction categories, alternatives, and areas of expected oil potential.

Land Cover Table

Alternative	Lease Type	Oil Potential	Land Cover Class													
			Bare-ground	Dwarf Shrub	Dwarf Shrub-Lichen	Fire Scar	Fresh-water or Salt-water	Herba-ceous (Marsh)	Herba-ceous (Mesic)	Herba-ceous (Wet)	Herba-ceous (Wet-Marsh) (Tidal)	Low Shrub	Sparse Vegeta-tion (North-ern and West-ern Alaska)	Tall Shrub (Open-Closed)	Tussock Tundra (Low shrub or Herba-ceous)	Total
B	No Sale/No Occu-pancy	Low	3.05	0.25	–	–	4.68	<0.01	23.74	14.31	0.20	20.88	<0.01	–	20.98	88.08
		Medium	3.75	0.30	–	–	7.84	0.01	27.72	16.45	<0.01	9.01	0.36	–	9.37	74.82
		High	0.51	1.74	–	<0.01	21.37	2.82	20.36	29.88	0.61	2.79	20.57	<0.01	2.50	103.17
		Total	7.31	2.30	–	<0.01	33.89	2.83	71.83	60.64	0.81	32.68	20.93	<0.01	32.86	266.08
	Timing Limita-tions	Low	1.24	1.37	–	<0.01	5.26	<0.01	83.98	51.05	0.18	116.55	0.31	0.01	123.98	383.93
		Medium	0.90	0.98	–	–	12.20	0.01	153.89	70.34	0.46	64.51	1.61	–	110.70	415.60
		High	0.07	0.46	–	<0.01	0.04	0.04	30.53	3.62	–	4.08	0.97	–	16.03	55.85
		Total	2.21	2.81	–	<0.01	17.51	0.05	268.40	125.01	0.65	185.14	2.89	0.01	250.71	855.39
	No Restric-tions	Low	–	–	–	–	4.26	–	–	<0.01	–	<0.01	–	–	0.00	4.26
		Medium	0.51	0.41	–	<0.01	40.64	0.05	62.86	34.25	0.51	14.60	0.23	<0.01	42.14	196.19
		High	0.27	2.24	<0.01	0.01	39.66	3.03	86.46	36.83	0.83	12.91	5.26	–	81.39	268.89
		Total	0.78	2.65	<0.01	0.01	84.56	3.08	149.32	71.08	1.34	27.50	5.49	<0.01	123.53	469.34
C	No Sale/No Occu-pancy	Low	3.86	0.74	–	–	14.05	0.01	88.06	60.08	0.38	124.67	0.00	–	114.94	406.79
		Medium	4.43	0.59	–	–	50.98	0.01	103.83	65.26	0.96	30.55	0.36	–	39.35	296.32
		High	0.70	1.80	<0.01	0.01	55.62	3.80	30.66	39.52	1.19	5.36	21.18	<0.01	5.33	165.18
		Total	8.99	3.13	<0.01	0.01	120.65	3.82	222.55	164.86	2.53	160.58	21.54	<0.01	159.62	868.29

Land Cover Table

Alternative	Lease Type	Oil Potential	Land Cover Class													
			Bare-ground	Dwarf Shrub	Dwarf Shrub-Lichen	Fire Scar	Fresh-water or Salt-water	Herba-ceous (Marsh)	Herba-ceous (Mesic)	Herba-ceous (Wet)	Herba-ceous (Wet-Marsh) (Tidal)	Low Shrub	Sparse Vegeta-tion (North-ern and West-ern Alaska)	Tall Shrub (Open-Closed)	Tussock Tundra (Low shrub or Herba-ceous)	Total
	Timing Limita-tions	Low	0.43	0.88	–	<0.01	0.08	–	19.66	5.28	–	12.75	0.30	0.01	30.03	69.42
		Medium	0.50	0.72	–	–	3.12	0.01	82.36	24.64	0.00	43.19	1.61	–	81.91	238.05
		High	0.07	0.45	–	<0.01	0.04	0.04	30.13	3.40	–	3.86	0.97	–	15.58	54.54
		Total	1.00	2.06	–	<0.01	3.23	0.05	132.15	33.31	0.00	59.80	2.89	0.01	127.51	362.02
	No Restric-tions	Low	–	–	–	–	0.07	–	–	–	–	<0.01	–	–	<0.01	0.07
		Medium	0.22	0.38	–	<0.01	6.59	0.04	58.29	31.14	0.01	14.39	0.23	<0.01	40.96	152.25
		High	0.08	2.19	–	0.01	5.41	2.05	76.56	27.41	0.26	10.55	4.65	–	79.01	208.18
		Total	0.30	2.57	–	0.01	12.07	2.09	134.85	58.55	0.27	24.94	4.89	<0.01	119.96	360.50
D1	No Sale/No Occu-pancy	Low	4.29	1.59	–	<0.01	14.21	0.01	106.04	65.07	0.38	134.91	0.31	0.01	138.48	465.29
		Medium	5.15	1.24	–	<0.01	56.23	0.05	185.89	101.17	0.96	64.22	1.96	–	104.61	521.50
		High	0.84	3.54	<0.01	0.01	60.80	5.54	66.89	59.31	1.44	12.71	25.72	<0.01	26.77	263.58
		Total	10.28	6.37	<0.01	0.01	131.24	5.60	358.82	225.55	2.79	211.84	27.98	0.01	269.87	1,250.36
	Con-trolled Use	Low	–	0.03	–	–	–	–	1.68	0.29	–	2.52	–	–	6.48	10.99
		Medium	–	0.28	–	–	0.16	<0.01	22.92	2.01	–	16.47	0.13	–	38.50	80.47
		High	–	0.24	–	–	0.01	0.01	19.62	0.85	–	1.29	0.11	–	10.27	32.40
		Total	<0.01	0.55	–	<0.01	0.17	0.01	44.22	3.15	–	20.27	0.24	–	55.25	123.86
	No Restric-tions	Low	<0.01	<0.01	–	–	<0.01	–	<0.01	<0.01	–	<0.01	–	–	–	<0.01
		Medium	<0.01	0.17	–	<0.01	4.29	0.01	35.66	17.86	0.01	7.44	0.12	<0.01	19.10	84.66
		High	0.01	0.67	–	<0.01	0.26	0.34	50.85	10.17	–	5.77	0.97	–	62.88	131.92
		Total	0.02	0.84	–	<0.01	4.55	0.35	86.51	28.03	0.01	13.21	1.09	<0.01	81.98	216.58

Land Cover Table

Alternative	Lease Type	Oil Potential	Land Cover Class													
			Bare-ground	Dwarf Shrub	Dwarf Shrub-Lichen	Fire Scar	Fresh-water or Salt-water	Herba-ceous (Marsh)	Herba-ceous (Mesic)	Herba-ceous (Wet)	Herba-ceous (Wet-Marsh) (Tidal)	Low Shrub	Sparse Vegeta-tion (North-ern and West-ern Alaska)	Tall Shrub (Open-Closed)	Tussock Tundra (Low shrub or Herba-ceous)	Total
D2	No Sale/No Occu-pancy	Low	4.29	1.59	–	<0.01	14.21	0.01	106.04	65.07	0.38	134.91	0.31	0.01	138.48	465.29
		Medium	5.15	1.24	–	<0.01	56.23	0.05	185.89	101.17	0.96	64.22	1.96	–	104.61	521.50
		High	0.84	3.54	<0.01	0.01	60.80	5.54	66.89	59.31	1.44	12.71	25.72	<0.01	26.77	263.58
		Total	10.28	6.37	<0.01	0.01	131.24	5.60	358.82	225.55	2.79	211.84	27.98	0.01	269.87	1,250.36
	Con-trolled Use	Low	–	0.03	–	–	–	–	1.68	0.29	–	2.52	–	–	6.48	10.99
		Medium	–	0.28	–	–	0.16	0.00	22.92	2.01	–	16.47	0.13	–	38.50	80.47
		High	–	0.24	–	–	0.01	0.01	19.62	0.85	–	1.29	0.11	–	10.27	32.40
		Total	<0.01	0.55	–	<0.01	0.17	0.01	44.22	3.15	–	20.27	0.24	–	55.25	123.86
	Timing Limita-tions	Low	<0.01	0.00	–	–	<0.01	–	<0.01	<0.01	–	<0.01	–	–	–	<0.01
		Medium	<0.01	0.17	–	<0.01	4.29	0.01	35.66	17.86	0.01	7.44	0.12	<0.01	19.10	84.66
		High	0.01	0.67	–	<0.01	0.26	0.34	50.85	10.17	–	5.77	0.97	–	62.88	131.92
		Total	0.02	0.84	–	<0.01	4.55	0.35	86.51	28.03	0.01	13.21	1.09	<0.01	81.98	216.58

Table H-4

Acres (1000s) within different levels of use (percent of years caribou present) by parturient Porcupine Caribou during calving, by different lease restriction categories, alternatives, and areas of expected oil potential.

PCH Calving Table

Alternative	Lease Type	Percent Of Years Present	Oil Potential			
			High	Medium	Low	Total
B	No Sale/No Occupancy	< 20%	94.4	6.0		100.4
		20 - 30%	1.6	4.9		6.6
		30 - 40%		11.8	0.4	12.2
		> 40%		52.0	83.8	135.8
	Timing Limitations	< 20%	48.4	41.5	2.8	92.8
		20 - 30%	7.4	58.4	34.3	100.2
		30 - 40%		51.3	19.3	70.6
		> 40%		264.2	325.5	589.7
	No Restrictions	< 20%	226.3	36.5	0.0	262.7
		20 - 30%	14.0	33.1	0.3	47.4
		30 - 40%		74.1	0.0	74.2
		> 40%		23.1		23.1
C	No Sale/No Occupancy	< 20%	120.7	7.9	0.0	128.5
		20 - 30%	10.1	10.6	0.9	21.6
		30 - 40%		21.9	1.2	23.1
		> 40%		226.6	395.1	621.8
	Timing Limitations	< 20%	47.5	41.4	2.8	91.6
		20 - 30%	7.1	58.1	33.8	98.9
		30 - 40%		48.0	18.5	66.6
		> 40%		90.5	14.2	104.7
	No Restrictions	< 20%	201.0	34.8	0.0	235.8
		20 - 30%	5.8	27.8		33.6
		30 - 40%		67.3		67.3
		> 40%		22.2		22.2
D1	No Sale/No Occupancy	< 20%	205.3	44.1	2.8	252.2
		20 - 30%	22.6	58.7	27.6	108.9
		30 - 40%		70.3	16.7	87.0
		> 40%		318.9	408.4	727.3
	Controlled Use	< 20%	32.4	26.4	0.0	58.9
		20 - 30%	0.0	21.6	7.1	28.7
		30 - 40%		27.9	3.0	30.9
		> 40%		4.5	0.9	5.4
	No Restrictions	< 20%	131.5	13.4		144.9
		20 - 30%	0.4	16.2		16.6
		30 - 40%		39.0		39.0
		> 40%		16.0	0.0	16.0
D2	No Sale/No Occupancy	< 20%	205.3	44.1	2.8	252.2
		20 - 30%	22.6	58.7	27.6	108.9
		30 - 40%		70.3	16.7	87.0
		> 40%		318.9	408.4	727.3
	Controlled Use	< 20%	32.4	26.4	0.0	58.9
		20 - 30%	0.0	21.6	7.1	28.7
		30 - 40%		27.9	3.0	30.9
		> 40%		4.5	0.9	5.4

PCH Calving Table

Alternative	Lease Type	Percent Of Years Present	Oil Potential			
			High	Medium	Low	Total
	Timing Limitations	< 20%	131.5	13.4		144.9
		20 - 30%	0.4	16.2		16.6
		30 - 40%		39.0		39.0
		> 40%		16.0	0.0	16.0

Table H-5

Acres (1000s) within different levels of use (percent of years caribou present) by Porcupine Caribou during postcalving, by different lease restriction categories, alternatives, and areas of expected oil potential.

PCH Postcalving Table

Acres (x1000)		Percent of	Oil Potential			
Alternative	**Lease Type**	**Years Present**	**High**	**Medium**	**Low**	**Total**
B	No Sale/No Occupancy	< 20%	81.8	0.5	0.1	82.4
		20 - 30%	8.6	20.8	0.2	29.7
		30 - 40%	5.7	27.9	2.2	35.8
		> 40%		25.7	81.5	107.2
	Timing Limitations	< 20%		29.2	5.0	34.2
		20 - 30%		79.7	16.1	95.8
		30 - 40%	29.5	187.6	54.9	272.1
		> 40%	26.3	118.9	306.0	451.2
	No Restrictions	< 20%	113.6	57.9	0.4	171.9
		20 - 30%	80.4	91.9		172.3
		30 - 40%	46.2	16.9		63.2
		> 40%		0.1		0.1
C	No Sale/No Occupancy	< 20%	84.8	35.9	5.5	126.1
		20 - 30%	22.8	53.4	14.4	90.5
		30 - 40%	23.2	103.4	12.6	139.3
		> 40%		74.4	364.8	439.2
	Timing Limitations	< 20%		8.4		8.4
		20 - 30%		47.4	1.9	49.4
		30 - 40%	28.2	112.0	44.6	184.8
		> 40%	26.3	70.2	22.7	119.2
	No Restrictions	< 20%	110.6	43.4	0.0	154.0
		20 - 30%	66.3	91.6		157.9
		30 - 40%	30.0	16.9		46.9
		> 40%		0.1		0.1
D1	No Sale/No Occupancy	< 20%	124.5	69.4	5.5	199.4
		20 - 30%	46.3	129.8	16.3	192.4
		30 - 40%	52.3	180.7	48.9	281.9
		> 40%	4.8	112.1	384.8	501.7
	Controlled Use	< 20%				
		20 - 30%		2.7		2.7
		30 - 40%	10.9	45.1	8.3	64.3
		> 40%	21.5	32.6	2.7	56.8
	No Restrictions	< 20%	70.9	18.2		89.1
		20 - 30%	42.8	59.9		102.6
		30 - 40%	18.2	6.6		24.8
		> 40%		0.0	0.0	0.0
D2	No Sale/No Occupancy	< 20%	124.5	69.4	5.5	199.4
		20 - 30%	46.3	129.8	16.3	192.4
		30 - 40%	52.3	180.7	48.9	281.9
		> 40%	4.8	112.1	384.8	501.7
	Controlled Use	< 20%				
		20 - 30%		2.7		2.7
		30 - 40%	10.9	45.1	8.3	64.3
		> 40%	21.5	32.6	2.7	56.8

PCH Postcalving Table

Acres (x1000)		Percent of	Oil Potential			
Alternative	**Lease Type**	**Years Present**	**High**	**Medium**	**Low**	**Total**
	Timing Limitations	< 20%	70.9	18.2		89.1
		20 - 30%	42.8	59.9		102.6
		30 - 40%	18.2	6.6		24.8
		> 40%		0.0	0.0	0.0

Table H-6
Estimated percentage of Central Arctic Caribou Herd seasonal range (based on a utilization distribution from a kernel density estimate) by different lease restriction categories, alternatives, and areas of expected oil potential (see Appendix 3.3X CAH seasonal distribution figure).

CAH Percentage Kernel Density Table

Percent of CAH			Oil Potential			
Alternative	**Lease Type**	**Season**	**High**	**Medium**	**Low**	**Total**
B	No Sale/No Occupancy	Postcalving	0.214	0.029	0.002	0.245
		Mosquito	1.271	0.096	0.048	1.415
		Oestrid Fly	0.245	0.152	0.147	0.544
		Late Summer	0.102	0.046	0.086	0.233
	Timing Limitations	Postcalving	0.059	0.157	0.041	0.257
		Mosquito	0.677	0.921	0.300	1.897
		Oestrid Fly	0.216	0.775	0.562	1.554
		Late Summer	0.060	0.290	0.345	0.695
	No Restrictions	Postcalving	0.838	0.055	0.000	0.892
		Mosquito	2.995	0.285	0.002	3.281
		Oestrid Fly	0.698	0.186	0.001	0.885
		Late Summer	0.379	0.077	0.000	0.456
C	No Sale/No Occupancy	Postcalving	0.220	0.040	0.006	0.266
		Mosquito	1.524	0.312	0.226	2.062
		Oestrid Fly	0.415	0.354	0.551	1.320
		Late Summer	0.125	0.100	0.323	0.548
	Timing Limitations	Postcalving	0.059	0.146	0.037	0.241
		Mosquito	0.669	0.735	0.124	1.527
		Oestrid Fly	0.210	0.585	0.158	0.953
		Late Summer	0.060	0.236	0.107	0.403
	No Restrictions	Postcalving	0.833	0.055		0.887
		Mosquito	2.751	0.254		3.005
		Oestrid Fly	0.534	0.175		0.710
		Late Summer	0.357	0.077		0.433
D1	No Sale/No Occupancy	Postcalving	0.469	0.135	0.033	0.637
		Mosquito	2.667	0.855	0.327	3.849
		Oestrid Fly	0.708	0.805	0.682	2.195
		Late Summer	0.258	0.270	0.413	0.941
	Controlled Use	Postcalving	0.043	0.077	0.010	0.130
		Mosquito	0.469	0.322	0.023	0.814
		Oestrid Fly	0.123	0.220	0.027	0.370
		Late Summer	0.037	0.114	0.018	0.169
	No Restrictions	Postcalving	0.599	0.029		0.628
		Mosquito	1.807	0.124		1.931
		Oestrid Fly	0.329	0.089		0.417
		Late Summer	0.246	0.028		0.274
D2	No Sale/No Occupancy	Postcalving	0.469	0.135	0.033	0.637
		Mosquito	2.667	0.855	0.327	3.849
		Oestrid Fly	0.708	0.805	0.682	2.195
		Late Summer	0.258	0.270	0.413	0.941

CAH Percentage Kernel Density Table

Percent of CAH			Oil Potential			
Alternative	**Lease Type**	**Season**	**High**	**Medium**	**Low**	**Total**
	Controlled Use	Postcalving	0.043	0.077	0.010	0.130
		Mosquito	0.469	0.322	0.023	0.814
		Oestrid Fly	0.123	0.220	0.027	0.370
		Late Summer	0.037	0.114	0.018	0.169
	Timing Limitations	Postcalving	0.599	0.029		0.628
		Mosquito	1.807	0.124		1.931
		Oestrid Fly	0.329	0.089		0.417
		Late Summer	0.246	0.028		0.274

VEGETATION AND WETLANDS

Table H-7
Vegetation and Land Cover Types in the Arctic Refuge Program Area*

Vegetation or Land Cover Type	Area (acres)	% of Coastal Plain
Bareground	10,200	0.7
Dwarf Shrub	7,800	0.5
Freshwater or Saltwater	134,900	8.6
Herbaceous (Marsh)	6,000	0.4
Herbaceous (Mesic)	477,600	30.5
Herbaceous (Wet)	252,100	16.1
Herbaceous (Wet-Marsh) (Tidal)	2,800	0.2
Low Shrub	242,300	15.5
Sparse Vegetation	29,300	1.9
Tussock Tundra (Low shrub or Herbaceous)	400,400	25.6
Total area	1,563,400	100.0

*Derived from broad-scale land cover mapping for Alaska prepared by Boggs et al. (2016)
Source: Boggs et al. (2016)

Table H-8
Rare Vascular Plant Taxa with Documented Occurrences in the Arctic Refuge Program Area

Taxa	State Rank	Global Rank	Federal Listings
Cardamine microphylla	S2	G3G4	BLM Watch
Carex atherodes	S3S4	G5	
Chrysosplenium rosendahlii	S1S2	G4G5Q	
Draba subcapitata	S1S2	G4	BLM Watch
Festuca viviparoidea ssp. *viviparoidea*	SU	G4G5	
Papaver gorodkovii	S2S3	G3	BLM Sensitive
Puccinellia andersonii	S1S2	G3G5	
Puccinellia vahliana	S3	G4	BLM Watch
Saxifraga rivularis ssp. *arctolitoralis*	S2	G5T2T3	
Smelowskia media	S2S3	GNR	BLM Watch
Symphyotrichum pygmaeum	S2	G2G4	BLM Sensitive
Erigeron murii	S2S3	G2G3	BLM Sensitive
Erigeron porsildii	S3S4	G3G4	BLM Watch
Trisetum sibiricum ssp. *litorale*	S3	G5T4Q	BLM Sensitive

Source: Alaska Center for Conservation Science Rare Plant Data Portal (ACCS 2018)

Table H-9
Acreages of coarse scale vegetation types within Coastal Plain leasing Alternative B stratified by land-use category and hydrocarbon potential.

Vegetation Type within Land-use Categories	High hydrocarbon potential	% High HCP within land-use category	Medium hydrocarbon potential	% Medium HCP within land-use category	Low hydrocarbon potential	% low HCP within land-use category
OG-NSO-Total	**103,168.7**	**100.0**	**74,824.9**	**100.0**	**88084.6**	**100.0**
Bareground	510.7	0.5	3,749.3	5.0	3,047.0	3.5
Dwarf Shrub	1,743.6	1.7	304.6	0.4	251.8	0.3
Fire Scar	3.3	<0.1	-	-	-	-
Freshwater or Saltwater	21,368.4	20.7	7,842.1	10.5	4,678.8	5.3
Herbaceous (Marsh)	2,816.3	2.7	10.9	<0.1	4.7	<0.1
Herbaceous (Mesic)	20,364.2	19.7	27,723.0	37.1	23,738.8	26.9
Herbaceous (Wet)	29,877.9	29.0	16,451.7	22.0	14,307.7	16.2
Herbaceous (Wet-Marsh) (Tidal)	611.0	0.6	1.3	<0.1	199.0	0.2
Low Shrub	2,791.2	2.7	9,012.4	12.0	20,877.2	23.7
Sparse Vegetation	20,574.4	19.9	355.3	0.5	0.9	0.0
Tall Shrub (Open-Closed)	2.9	<0.1	-	-	-	-
Tussock Tundra	2,504.7	2.4	9,374.4	12.5	20,978.8	23.8
OG-SaleSTC-Total	**268,886.7**	**100.0**	**196,193.0**	**100.0**	**4262.6**	**100.0**
Bareground	271.8	0.1	509.6	0.3	-	-
Dwarf Shrub	2,244.0	0.8	406.9	0.2	-	-
Dwarf Shrub-Lichen	1.5	<0.1	-	-	-	-
Fire Scar	7.3	<0.1	1.1	<0.1	-	-
Freshwater or Saltwater	39,658.8	14.7	40,640.7	20.7	4,262.4	100.0
Herbaceous (Marsh)	3,031.5	1.1	46.7	0.0	-	-
Herbaceous (Mesic)	86,459.8	32.2	62,863.3	32.0	-	-
Herbaceous (Wet)	36,828.1	13.7	34,251.1	17.5	0.1	<0.1
Herbaceous (Wet-Marsh) (Tidal)	832.5	0.3	505.2	0.3	-	-
Low Shrub	12,906.0	4.8	14,596.4	7.4	<0.1	<0.1

Table H-9 *(continued)*
Acreages of coarse scale vegetation types within Coastal Plain leasing Alternative B stratified by land-use category and hydrocarbon potential.

Vegetation Type within Land-use categories	High hydrocarbon potential	% High HCP within land-use category	Medium hydrocarbon potential	% Medium HCP within land-use category	Low hydrocarbon potential	% Low HCP within land-use category
Sparse Vegetation	5,259.5	2.0	231.3	0.1	-	-
Tall Shrub (Open-Closed)	-	-	0.2	<0.1	-	-
Tussock Tundra	81,385.8	30.3	42,140.4	21.5	<0.1	<0.1
OG-TL-Total	**55,848.6**	**100.0**	**415,604.1**	**100.0**	**383,934.9**	**100.0**
Bareground	70.3	0.1	895.7	0.2	1,241.9	0.3
Dwarf Shrub	457.9	0.8	984.4	0.2	1,365.2	0.4
Fire Scar	0.2	<0.1	-	-	1.8	<0.1
Freshwater or Saltwater	42.9	0.1	12,198.8	2.9	5,264.5	1.4
Herbaceous (Marsh)	42.5	0.1	9.8	<0.1	1.6	<0.1
Herbaceous (Mesic)	30,533.6	54.7	153,889.7	37.0	83,979.0	21.9
Herbaceous (Wet)	3,623.0	6.5	70,335.6	16.9	51,049.8	13.3
Herbaceous (Wet-Marsh) (Tidal)	-	-	462.5	0.1	184.5	<0.1
Low Shrub	4,079.5	7.3	64,514.4	15.5	116,548.0	30.4
Sparse Vegetation	969.9	1.7	1,614.3	0.4	305.1	0.1
Tall Shrub (Open-Closed)	-	-	-	-	8.8	<0.1
Tussock Tundra	16,028.8	28.7	110,698.9	26.6	123,985.0	32.3
Grand Total	**427,904.0**		**686,622.1**		**476,282.1**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables

Table H-10.

Acreages of coarse scale wetland types within Coastal Plain leasing Alternative B stratified by land-use category and hydrocarbon potential.

Wetland Types within Land-use Categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-NSO	**101,960.1**	**100.0**	**68,214.1**	**100.0**	**82,728.1**	**100.0**
Estuarine and Marine Deepwater	6,604.1	6.5	3.9	<0.1	1.3	<0.1
Estuarine and Marine Wetland	1,916.0	1.9	6.8	<0.1	48.3	0.1
Freshwater Emergent Wetland	55,372.6	54.3	48,152.7	70.6	68,658.2	83.0
Freshwater Forested/Shrub Wetland	9,104.0	8.9	10,767.2	15.8	8,077.5	9.8
Freshwater Pond	1,581.7	1.6	379.6	0.6	90.5	0.1
Lake	2,496.9	2.4	532.7	0.8	159.1	0.2
Riverine	24,884.8	24.4	8,371.2	12.3	5,693.3	6.9
OG-SaleSTC	**268,097.7**	**100.0**	**195,427.1**	**100.0**	**4,263.0**	**100.0**
Estuarine and Marine Deepwater	29,255.1	10.9	30,780.6	15.8	4,200.2	98.5
Estuarine and Marine Wetland	4,212.0	1.6	3,033.1	1.6	60.5	1.4
Freshwater Emergent Wetland	196,497.8	73.3	151,651.3	77.6	2.3	0.1
Freshwater Forested/Shrub Wetland	27,625.0	10.3	5,648.3	2.9	-	-
Freshwater Pond	1,104.0	0.4	1,165.0	0.6	-	-
Lake	4,749.3	1.8	2,157.6	1.1	-	-
Riverine	4,654.6	1.7	991.3	0.5	-	-
OG-TL	**55,483.3**	**100.0**	**386,343.9**	**100.0**	**370,015.1**	**100.0**
Estuarine and Marine Deepwater	-	-	235.7	0.1	297.6	0.1
Estuarine and Marine Wetland	-	-	249.2	0.1	304.3	0.1
Freshwater Emergent Wetland	51,782.0	93.3	355,097.4	91.9	354,148.6	95.7
Freshwater Forested/Shrub Wetland	2,759.8	5.0	22,887.4	5.9	11,082.3	3.0
Freshwater Pond	12.4	0.0	1,217.4	0.3	355.3	0.1
Lake	-	-	2,058.2	0.5	391.4	0.1
Riverine	929.0	1.7	4,598.6	1.2	3,435.5	0.9
Grand Total	**425,541.1**		**649,985.1**		**457,006.2**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables

Table H-11.
Acreages of coarse scale vegetation types within Coastal Plain leasing Alternative C stratified by land-use category and hydrocarbon potential.

Vegetation types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-NSO	165,182.2	100.0	185,793.4	100.0	40,951.0	100.0
Bareground	704.6	0.4	3,617.2	1.9	1,917.4	4.7
Dwarf Shrub	1,802.6	1.1	392.8	0.2	356.3	0.9
Dwarf Shrub-Lichen	1.5	<0.1	-	-	-	-
Fire Scar	5.6	<0.1	-	-	-	-
Freshwater or Saltwater	55,621.2	33.7	44,653.5	24.0	5,634.9	13.8
Herbaceous (Marsh)	3,803.1	2.3	14.9	<0.1	1.8	0.0
Herbaceous (Mesic)	30,661.2	18.6	59,502.2	32.0	11,829.4	28.9
Herbaceous (Wet)	39,520.2	23.9	38,878.0	20.9	6,872.3	16.8
Herbaceous (Wet-Marsh) (Tidal)	1,185.0	0.7	960.5	0.5	27.5	0.1
Low Shrub	5,364.3	3.2	15,890.7	8.6	7,554.2	18.4
Sparse Vegetation	21,179.4	12.8	355.3	0.2	4.0	0.0
Tall Shrub (Open-Closed)	2.9	0.0	-	-	-	-
Tussock Tundra	5,330.7	3.2	21,528.2	11.6	6,753.2	16.5
OG-SaleSTC	**208,181.5**	**100.0**	**152,246.5**	**100.0**	**73.9**	**100.0**
Bareground	77.9	<0.1	219.8	0.1	-	-
Dwarf Shrub	2,188.0	1.1	381.5	0.3	-	-
Fire Scar	5.1	<0.1	1.1	<0.1	-	-
Freshwater or Saltwater	5,412.3	2.6	6,587.5	4.3	73.9	100.0
Herbaceous (Marsh)	2,051.0	1.0	43.2	<0.1	-	-
Herbaceous (Mesic)	76,561.7	36.8	58,291.2	38.3	-	-
Herbaceous (Wet)	27,413.1	13.2	31,140.0	20.5	-	-
Herbaceous (Wet-Marsh) (Tidal)	258.4	0.1	8.5	<0.1	-	-

Table H-11 *(continued)*
Acreages of coarse scale vegetation types within Coastal Plain leasing Alternative C stratified by land-use category and hydrocarbon potential.

Vegetation types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
Low Shrub	10,554.2	5.1	14,386.7	9.4	<0.1	<0.1
Sparse Vegetation	4,654.5	2.2	231.3	0.2	-	-
Tall Shrub (Open-Closed)	-	-	0.2	<0.1	-	-
Tussock Tundra	79,005.3	38.0	40,955.5	26.9	<0.1	<0.1
OG-TL	**54,540.3**	**100.0**	**238,054.0**	**100.0**	**69,423.0**	**100.0**
Bareground	70.3	0.1	501.2	0.2	432.6	0.6
Dwarf Shrub	455.0	0.8	722.0	0.3	879.0	1.3
Fire Scar	0.2	<0.1	-	-	1.8	<0.1
Freshwater or Saltwater	36.7	0.1	3,115.8	1.3	77.8	0.1
Herbaceous (Marsh)	36.2	0.1	9.3	<0.1	-	-
Herbaceous (Mesic)	30,134.7	55.3	82,355.3	34.6	19,661.8	28.3
Herbaceous (Wet)	3,395.6	6.2	24,639.6	10.4	5,279.7	7.6
Herbaceous (Wet-Marsh) (Tidal)			<0.1	<0.1	-	-
Low Shrub	3,858.3	7.1	43,191.3	18.1	12,754.1	18.4
Sparse Vegetation	969.9	1.8	1,614.3	0.7	301.9	0.4
Tall Shrub (Open-Closed)			-	-	8.8	<0.1
Tussock Tundra (Low shrub or Herbaceous)	15,583.3	28.6	81,905.3	34.4	30,025.4	43.2
Grand Total	**427,904.0**		**686,622.1**		**476,282.1**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables

Table H-12

Acreages of coarse scale wetland types within Coastal Plain leasing Alternative C stratified by land-use category and hydrocarbon potential.

Wetland types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-NSO	**163,865.8**	**100.0**	**178,878.2**	**100.0**	**28,699.5**	**100.0**
Estuarine and Marine Deepwater	34,894.4	21.3	30,852.8	17.2	4,190.6	14.6
Estuarine and Marine Wetland	5,700.9	3.5	3,210.0	1.8	87.7	0.3
Freshwater Emergent Wetland	77,451.1	47.3	124,465.6	69.6	20,923.8	72.9
Freshwater Forested/Shrub Wetland	14,514.4	8.9	11,207.8	6.3	1,929.0	6.7
Freshwater Pond	1,766.2	1.1	677.4	0.4	52.1	0.2
Lake	3,749.0	2.3	966.4	0.5	-	-
Riverine	25,789.9	15.7	7,498.1	4.2	1,516.4	5.3
OG-SaleSTC	**207,496.2**	**100.0**	**151,463.4**	**100.0**	**73.9**	**100.0**
Estuarine and Marine Deepwater	964.8	0.5	167.4	0.1	43.5	58.9
Estuarine and Marine Wetland	427.2	0.2	79.1	0.1	30.4	41.2
Freshwater Emergent Wetland	175,653.7	84.7	141,404.4	93.4	<0.1	<0.1
Freshwater Forested/Shrub Wetland	22,274.8	10.7	5,646.0	3.7	-	-
Freshwater Pond	924.5	0.4	1,143.9	0.8	-	-
Lake	3,497.2	1.7	2,111.7	1.4	-	-
Riverine	3,754.1	1.8	910.9	0.6	-	-
OG-TL	**54,179.1**	**100.0**	**209,866.1**	**100.0**	**65,728.5**	**100.0**
Freshwater Emergent Wetland	50,547.6	93.3	185,515.4	88.4	59,889.3	91.1
Freshwater Forested/Shrub Wetland	2,699.6	5.0	20,576.8	9.8	4,547.7	6.9
Freshwater Pond	7.4	<0.1	426.5	0.2	11.4	<0.1
Lake	-	-	401.9	0.2	-	-
Riverine	924.5	1.7	2,945.5	1.4	1,280.2	1.9
Grand Total	**425,541.1**		**649,985.1**		**457,006.2**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables

Table H-13

Acreages of coarse scale vegetation types within Coastal Plain leasing Alternatives D1 and D2 stratified by land-use category and hydrocarbon potential.

Wetland types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-CSU	**32,403.9**	**100.0**	**80,466.7**	**100.0**	**10,993.2**	**100.0**
Dwarf Shrub	239.9	0.7	281.2	0.3	28.9	0.3
Freshwater or Saltwater	14.2	<0.1	157.5	0.2	-	-
Herbaceous (Marsh)	5.7	<0.1	0.7	0.0	-	-
Herbaceous (Mesic)	19,623.7	60.6	22,920.0	28.5	1,678.8	15.3
Herbaceous (Wet)	848.2	2.6	2,010.6	2.5	289.5	2.6
Low Shrub	1,292.6	4.0	16,465.5	20.5	2,516.5	22.9
Sparse Vegetation	113.3	0.3	126.8	0.2	-	-
Tussock Tundra	10,266.4	31.7	38,504.3	47.9	6,479.5	58.9
OG-NSO	**256,247.3**	**100.0**	**400,842.8**	**100.0**	**67,319.2**	**100.0**
Bareground	832.1	0.3	3,898.4	1.0	631.2	0.9
Dwarf Shrub	3,423.2	1.3	1,045.4	0.3	854.9	1.3
Dwarf Shrub-Lichen	1.5	<0.1	-	-	-	-
Fire Scar	9.6	<0.1	0.2	<0.1	1.8	<0.1
Freshwater or Saltwater	60,656.5	23.7	49,135.8	12.3	4,973.3	7.4
Herbaceous (Marsh)	5,282.5	2.1	52.5	<0.1	0.1	<0.1
Herbaceous (Mesic)	63,070.5	24.6	136,321.4	34.0	19,065.2	28.3
Herbaceous (Wet)	57,710.2	22.5	72,451.6	18.1	6,006.2	8.9
Herbaceous (Wet-Marsh) (Tidal)	1,443.4	0.6	961.6	0.2	27.5	<0.1
Low Shrub	12,448.5	4.9	48,638.0	12.1	11,123.5	16.5
Sparse Vegetation	24,962.4	9.7	1,959.0	0.5	300.4	0.4
Tall Shrub (Open-Closed)	2.9	<0.1	-	-	5.4	<0.1
Tussock Tundra (Low shrub or Herbaceous)	26,403.9	10.3	86,378.8	21.5	24,329.7	36.1

Table H-13 *(continued)*

Acreages of coarse scale vegetation types within Coastal Plain leasing Alternatives D1 and D2 stratified by land-use category and hydrocarbon potential.

Wetland types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-SaleSTC (for D1) or OG-TL (for D2)	**131,923.0**	**100.0**	**84,658.9**	**100.0**	<0.1	**100.0**
Bareground	14.1	<0.1	3.4	<0.1	<0.1	28.6
Dwarf Shrub	669.7	0.5	169.7	0.2	<0.1	6.0
Fire Scar	1.3	<0.1	0.9	<0.1	-	-
Freshwater or Saltwater	256.6	0.2	4,292.9	5.1	<0.1	45.5
Herbaceous (Marsh)	339.7	0.3	14.2	<0.1	-	-
Herbaceous (Mesic)	50,845.2	38.5	35,664.7	42.1	<0.1	4.5
Herbaceous (Wet)	10,172.4	7.7	17,855.8	21.1	<0.1	12.4
Herbaceous (Wet-Marsh) (Tidal)	-	-	7.3	<0.1	-	-
Low Shrub	5,771.8	4.4	7,436.1	8.8	<0.1	3.0
Sparse Vegetation	974.0	0.7	115.1	0.1	-	-
Tall Shrub (Open-Closed)	-	-	0.2	<0.1	-	-
Tussock Tundra	62,878.3	47.7	19,098.5	22.6	-	-
Grand Total	**427,904.0**		**686,622.1**		**476282.1**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables.

Table H-14

Acreages of coarse scale wetland types within Coastal Plain leasing Alternatives D1 and D2 stratified by land-use category and hydrocarbon potential.

Wetland types within land-use categories	High hydrocarbon potential	% High HCP within land-use categories	Medium hydrocarbon potential	% Medium HCP within land-use categories	Low hydrocarbon potential	% Low HCP within land-use categories
OG-CSU	**32403.9**	**100.0**	**79237.8**	**100.0**	**10952.0**	**100.0**
Freshwater Emergent Wetland	31743.8	98.0	70976.6	89.6	10616.4	96.9
Freshwater Forested/Shrub Wetland	548.6	1.7	7943.5	10.0	264.3	2.4
Freshwater Pond	4.6	<0.1	30.3	<0.1	2.5	<0.1
Lake	-	-	65.8	0.1	-	-
Riverine	106.9	0.3	221.6	0.3	68.9	0.6
OG-NSO	**254499.9**	**100.0**	**366609.1**	**100.0**	**61817.9**	**100.0**
Estuarine and Marine Deepwater	35793.3	14.1	30999.7	8.5	4234.1	6.8
Estuarine and Marine Wetland	6112.7	2.4	3280.2	0.9	118.2	0.2
Freshwater Emergent Wetland	148065.7	58.2	294108.0	80.2	51492.6	83.3
Freshwater Forested/Shrub Wetland	26241.9	10.3	25216.6	6.9	4662.2	7.5
Freshwater Pond	2556.2	1.0	1329.4	0.4	40.1	0.1
Lake	7150.8	2.8	2112.6	0.6	-	-
Riverine	28579.3	11.2	9562.5	2.6	1270.8	2.1
OG-SaleSTC (for D1) or OG-TL (for	**131316.3**	**100.0**	**84244.8**	**100.0**	<0.1	**100.0**
Estuarine and Marine Deepwater	65.9	0.1	20.5	<0.1	-	-
Estuarine and Marine Wetland	15.4	<0.1	8.9	<0.1	-	-
Freshwater Emergent Wetland	118032.7	89.9	79974.5	94.9	<0.1	16.4
Freshwater Forested/Shrub Wetland	11836.5	9.0	1778.0	2.1	<0.1	18.4
Freshwater Pond	122.5	0.1	886.3	1.1	-	-
Lake	95.3	0.1	1301.6	1.5	-	-
Riverine	1148.0	0.9	274.9	0.3	<0.1	65.2
Grand Total	**425541.1**		**649985.1**		**457006.2**	

Tables were generated by intersecting multiple GIS datasets using acreages calculated in GIS and rounded to the nearest 0.1 of an acre. Totals may not match the rounded Alternative summary acreage tables

Appendix I
Fish and Aquatic Species

Appendix I. Fish and Aquatic Species

I.1 FRESHWATER FISH

Many of the resident freshwater fish discussed below have at least some ability to tolerate brief periods of saline waters (USFWS 2015). Additional freshwater species not listed here, such as slimy sculpin, lake trout, and arctic char, have been reported in other parts of the Arctic Refuge, and may be present (but not yet confirmed) in waters of the Program Area (BLM 2012). Table A1 summarizes habitat use and life history information for common species in the Program Area.

Round whitefish is a relatively small, benthic invertebrate feeding whitefish found in clearwater rivers and lakes in northern latitudes of North America and northeast Asia. The vast majority of round whitefish are resident freshwater fish, but some may tolerate brief periods in brackish waters. In the Program Area, these fish are found only in the Canning River. They are relatively less migratory in behavior than other whitefish. They are a minor component of subsistence catch due to low density.

Arctic grayling live in lakes and streams throughout northern North America and Asia and are found abundantly throughout the Arctic Refuge Coastal Plain. They exhibit very limited salinity tolerance. Adults feed on aquatic and terrestrial invertebrates and are capable of extensive annual movements between overwintering sites and summer feeding habitats. Though they constitute a minor subsistence component, recreational fishing for arctic grayling is likely common for residents of Kaktovik.

Burbot is large freshwater cod that inhabits deep areas of rivers and lakes throughout the circumpolar north (Evenson 1990; USFWS 2015). In the Program Area, burbot are found in waters along the Canning River (Smith and Glesne 1983; USFWS 2015). Burbot feed on insect larvae and other invertebrates as juveniles, but move to a fish diet around age 4.

Ninespine stickleback are found throughout northern waters of North America. In the Arctic Refuge it is found in lakes, rivers and streams and is tolerant of saline waters up to 20 parts per thousand (ppt). This small, relatively short-lived species is present in large numbers throughout its range. Ninespine stickleback feed on small crustaceans and insects. They themselves are a major prey item for many larger species of fish as well as birds. Ninespine stickleback overwinter in freshwater habitats in the Program Area.

I.2 ANADROMOUS FISH

There are at least nine species of anadromous fish in the Program Area. Most use this area and adjacent coastal waters seasonally for foraging or migration to other habitats. Pacific salmon are at the northern portion of their range in the Project Area, though their numbers appear to be increasing with warming trends in the region. Whitefish are common in the Program Area and are extremely important to subsistence communities. Dolly Varden are the only sport/subsistence fish that overwinters in the Program Area and its numbers are therefore limited by available in spawning and overwintering habitat. For brevity, some of the following species are discussed within the context of family groups with similar life histories.

Pacific salmon (*Onchorhynchus* spp.) are represented by three primary species that have been reported in coastal waters adjacent to the Program Area; pink salmon, chum salmon, and Chinook

salmon. Chinook salmon have not been reported in streams in the area, but several reports of chum salmon have been noted in the Canning River (Smith and Glesne 1983; USFWS 2015). Pink salmon are found in the Staines and Canning River complex. Pink salmon feed on plankton, larval fishes, fish eggs, and aquatic invertebrates. Juveniles of chum and Chinook salmon consume copepods and amphipods before switching to a diet of fish as sub-adults and adults whereupon they reach large sizes (Bradford et al. 2009; Horne-Brine et al. 2009; Salo 1991). All spawn in freshwater streams where the young emerge from gravel and disperse to the sea; almost immediately for chum and pink salmon and after a period of a year or more for Chinook salmon (Salo 1991; USFWS 2015). Depending on the species, each salmon spends between 1 and 5 years at sea before returning to freshwater to spawn and die.

Whitefish (***Coregonus* spp.**) are important subsistence fishes and, in addition to the mostly freshwater round whitefish, are represented by four anadromous species found either in Arctic Refuge Coastal Plain streams or in the adjacent coastal waters: humpback whitefish, least cisco, broad whitefish, and arctic cisco. Each species displays a different degree of freshwater and saline water reliance during their life. All are relatively long-lived (up to 20 years and older). Because waters of the Program Area do not support overwintering or spawning habitat sufficient for these species, they are found only in the adjacent coastal waters as they migrate or forage. Humpback whitefish are medium sized, benthic invertebrate-feeding fish that are found in rivers lakes and estuaries in Asia and North America. In the Arctic Refuge Coastal Plain region, they are only rarely documented in adjacent nearshore waters as they forage during summer months. Though they are rarely targeted for subsistence, they are a common bycatch species. Least cisco are a relatively small, pelagic-feeding whitefish that is found in Arctic and sub-Arctic environments of Asia and North America. They are common in estuaries, rivers and lakes in northern Alaska, but are only found in coastal waters in or adjacent to the Arctic Refuge Coastal Plain during summer months as they forage before returning to deeper overwintering and spawning waters to the west or east (Seigle 2003; USFWS 2015). Least cisco may undertake extensive spawning, overwintering, and foraging migrations annually. As with humpback whitefish, they are caught mostly incidentally during subsistence activities and are commonly a source of dog food. Broad whitefish are a relatively large, primarily benthic-feeding fish that is very important in subsistence activities in northern Alaska, including in coastal waters adjacent to the Program Area. The species may exhibit freshwater resident or anadromous behavior, but those found near the Program Area during summer are overwintering and spawning elsewhere. Arctic cisco are a relatively small, pelagic-feeding species found in nearly all arctic waters. In Alaska, the evidence suggests that arctic cisco originate and later spawn in waters of the Mackenzie River drainage (Zimmerman et al. 2013; USFWS 2015). Arctic cisco are found foraging in Beaufort Sea coastal waters and overwintering in brackish waters of large rivers such as the Colville River to the west and Mackenzie River to the east. This is a fully anadromous species not known to reside in freshwaters. They are a prized subsistence species known for high fat content and good taste (Moulton et al. 2010).

Rainbow Smelt is a small schooling fish that spawns in freshwater but can be found extensively in nearshore brackish and marine waters throughout the ACP. They feed on a varied diet of crustacea, plankton, and various other aquatic invertebrates, as well as fish eggs and small fish. They are relatively short-lived (6 years) but can be highly migratory. It is unknown how common these fish are in the Program Area but they are known to have spawning populations in the Colville, Sag, Kuk, and Mackenzie Rivers (Craig 1984).

Dolly Varden is a coldwater species found in the higher latitude waters of North America, as well as Russia, Japan, and Korea. They are found widely within the northern portion of the Arctic Refuge and in several rivers of the Arctic Refuge Coastal Plain and adjacent coastal waters and can display resident and anadromous forms. In the Program Area, spawning populations are documented in the Canning, Hulahula (Brown et al. 2014; USFWS 2015), and Aichilik (USFWS 2015). Isolated resident populations are found in springs and lakes in the Canning (McCart and Craig 1973; USFWS 2015), Sadlerochit (USFWS 2015), and Jago (USFWS 2015) River drainages. Resident species are typically smaller and live shorter lives while anadromous forms are larger and longer-lived (Underwood et al. 1996; USFWS 2015). Anadromous forms typically migrate to brackish, nearshore waters of the Arctic Refuge Coastal Plain at ages 2–5 from their overwintering habitats in deep pools and spring-fed areas of the Arctic Refuge Coastal Plain rivers (Underwood et al. 1996; Fechhelm et al. 1997; USFWS 2015). They are a highly migratory species who feed on mysid shrimp and amphipods, exhibiting little piscivory. They are the primary species targeted in subsistence fisheries by Kaktovik residents on the Hulahula River and in coastal areas during summer.

1.3 COASTAL MARINE FISH

Although adult and juvenile stages of several species of marine fishes may use in coastal and lagoon waters adjacent to the Program Area, this section focuses on the four most commonly observed species. Additional species likely to occur in marine waters are described in the NPRA IAP EIS (BLM 2012).

Arctic cod are distributed throughout the entirety of the northern polar basin and may be the most abundant and widely distributed fish in the Beaufort Sea. They are common and often abundant in nearshore coastal waters adjacent to the Arctic Refuge Coastal Plain. They inhabit cold, saline waters, but are tolerant of fluxes in temperature, salinity, and are found nearshore, offshore and even lower reaches of large rivers. They are typically a small to medium sized species. They are common in nearshore coastal waters in summer and fall before moving into full-scale marine waters during winter. Arctic cod prey on amphidpods, copepods, and mysid shrimp and are themselves common prey for marine mammals, birds and fish (Craig et al. 1984; Frost and Lowry 1984; USFWS 2015). They are incidentally harvested during subsistence activities along the Beaufort Sea coast, including near Kaktovik.

Saffron cod are found throughout the North Pacific and in the Arctic Ocean. They are common and widely distributed in the Beaufort Sea and along the Arctic Refuge Coastal Plain. They are found from coastal lagoons to offshore marine waters and some lower reaches of large rivers. They range from medium to large in size and feed on mysid shrimp, amphipods, and decapods, with some piscivory upon reaching larger sizes (Ellis 1962; USFWS 2015).

Fourhorn sculpin are found throughout the circumpolar north including the Beaufort Sea coastline, and waters adjacent to the Arctic Refuge Coastal Plain where they are typically very abundant. They feed on mysids, amphipods, isopods, and small fish.

Arctic flounder are found in coastal marine waters of much of the Artic and sub-Arctic of North America and Siberia. They are commonly found in nearshore waters of the Beaufort Sea, including the waters adjacent to the Arctic Refuge Coastal Plain. They are a relatively medium sized species, which remain near to shorelines and lagoons but are sometimes found in lower river reaches (Bendock 1979; USFWS 2015). They feed on amphipods, mollusks, crustaceans, and small fish.

Table I-1
Life History Attributes for Fish Species that May Use the Program Area

Species	Lifespan (years)	Age at Maturity (years)	Spawning Behavior	Spawning in Program Area?	Habitat Use in Program Area	Feeding Behavior in Program Area	Subsistence Use in ACP
Arctic Cisco	~20	7–8	Semi-annual; Fall	No	Summer months migration and foraging in freshwater and coastal marine waters	Pelagic invertebrates	Extensive
Arctic Cod	6–7	2–3	Annual to semi-annual; Fall	Likely	Common in coastal marine waters for spawning and rearing	Amphipods, copepods, mysid shrimp	Limited
Arctic Flounder	9–12	4–5	Annual to semi-annual	Likely	Common during summer months in marine waters; lower river deltas	Amphipods, mollusks, crustacea, and small fish	Limited
Arctic Grayling	up to 18	4–8	Annual to semi-annual; Spring	Unknown	Summer months in some freshwater streams; limited use of marine waters	Aquatic and terrestrial invertebrates	Limited
Broad Whitefish	>20	5–8	Annual to semi-annual: Fall	No	Summer months migration and foraging in freshwater and coastal marine waters	Benthic invertebrates	Extensive
Burbot	>20	6–7	Semi-annual; Winter	No	Summer months in Canning River	Insect larve and other invertebrates as juveniles; fish diet as adults	Extensive
Chinook Salmon	~4–5	1–5	Once; Summer/Fall	No	Rare in coastal marine waters for migration and foraging	Copepods/amphipods (early) fish (later)	Limited
Chum Salmon	~4–5	2–6	Once; Summer/Fall	No	Migration and foraging in Canning and Staines rivers; coastal marine waters	Copepods/amphipods (early) fish (later)	Limited
Dolly Varden	Resident = 7 Anadromous = 10	Resident = 2–4 Anadromous = 4–8	Semi-annual; Fall	Yes	Common during summer and winter months in freshwater streams and springs; coastal marine waters; spawning and overwintering in freshwater springs	Resident = Dipteran larvae and macroinvertebrates Anadromous = Mysids,amphipods, and fish	Extensive

Table I-1
Life History Attributes for Fish Species that May Use the Program Area

Species	Lifespan (years)	Age at Maturity (years)	Spawning Behavior	Spawning in Program Area?	Habitat Use in Program Area	Feeding Behavior in Program Area	Subsistence Use in ACP
Fourhorn Sculpin	up to 14	3–9	Annual to semi-annual	Likely	Common in summer and fall in coastal marine waters; lower river deltas	Mysid shrimp, amphipods, isopods, fish	Limited
Humpback Whitefish	>20	5–11	Annual to semi-annual: Fall	No	Summer months migration and foraging in freshwater and coastal marine waters	Benthic invertebrates	Extensive
Least Cisco	>25	3–7	Annual to semi-annual; Fall	No	Summer months migration and foraging in freshwater and coastal marine waters	Pelagic invertebrates and small fish	Limited
Ninespine Stickleback	up to 5	1–2	Annual; Summer	Yes	Common during summer and winter months in marine waters; freshwater. Spawning, rearing, overwintering	aquatic and terrestrial insects, and crustacea	None
Pink Salmon	2	2	Once: Summer/Fall	No	Migration and foraging in Canning and Staines rivers; coastal marine waters	Plankton, larval fishes, fish eggs, aquatic invertebrates	Limited
Round Whitefish	>20	3–8	Annual to semi-annual	No	Summer months migration and foraging in Canning River and some marine waters	Benthic invertebrates	Limited
Rainbow Smelt	~6	2–6	Once; Summer/Fall	Unknown	Found in coastal marine waters; lower river deltas in summmer/fall	Copepods, fish eggs, algae as juveniles; decapods, mysid shrimp, copepod, ampipod, small fish and other invertebrates as adults	Limited
Saffron Cod	10–12	2–3	Annual to semi-annual: Fall	Likely	Common in coastal marine waters for spawning and rearing	Amphipods, copepods, decapods, mysid shrimp, some fish	Limited

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Appendix J
Subsistence Uses and Resources

Coastal Plain Leasing Program
Environmental Impact Statement
Subsistence

APPENDIX J:
Subsistence Data Tables and Figures

Prepared for
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July 18, 2018

TABLE OF CONTENTS

TABLES

Appendix J. Subsistence Data Tables and Figures

J.1 KAKTOVIK

J.1.1 Harvest Data

Table J-1
Kaktovik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[1]	Total Pounds[2]	Average HH Pounds	Per Capita Pounds	
1985	All Resources	100	93	91	83	100	-	61,663	1,163	328	100.0%
	Salmon	2	0	0	0	2	0	0	0	0	0.0%
	Non-Salmon Fish	100	86	81	45	93	6,866	11,403	215	61	18.5%
	Large Land Mammals	100	79	71	71	100	288	35,331	667	188	57.3%
	Small Land Mammals	60	52	52	31	24	427	160	3	1	0.3%
	Marine Mammals	88	69	57	41	86	174	10,762	203	57	17.5%
	Migratory Birds	83	76	71	48	57	964	3,388	64	18	5.5%
	Upland Game Birds	86	74	69	45	43	867	607	11	3	1.0%
	Vegetation	24	17	2	5	21	-	13	<1	<1	<0.1%
1986	All Resources	100	89	87	83	100	-	84,060	1,501	433	100.0%
	Non-Salmon Fish	96	75	72	66	87	4,416	6,951	124	36	8.3%
	Large Land Mammals	98	68	62	57	98	198	24,908	445	128	29.6%
	Small Land Mammals	47	45	40	19	30	183	39	1	<1	<0.1%
	Marine Mammals	96	64	60	64	96	-	49,723	888	256	59.2%
	Migratory Birds	-	-	-	-	-	273	1,673	30	9	2.0%
	Upland Game Birds	87	62	62	47	55	1,012	708	13	4	0.8%
	Eggs	2	2	2	0	2	4	1	<1	<1	<0.1%
	Vegetation	49	21	21	11	40	-	58	1	<1	0.1%
1992a	All Resources	96	89	89	83	92	-	170,939	2,713	886	100.0%
	Salmon	26	9	9	11	19	50	105	2	1	0.1%
	Non-Salmon Fish	94	83	81	70	68	18,415	22,847	363	118	13.4%
	Large Land Mammals	96	70	57	62	83	212	28,705	456	149	16.8%
	Small Land Mammals	47	43	38	21	19	213	162	3	1	0.1%
	Marine Mammals	89	64	40	70	87	-	115,645	1,836	599	67.7%
	Migratory Birds	83	62	51	47	70	970	2,702	43	14	1.6%
	Upland Game Birds	85	60	57	47	49	769	539	9	3	0.3%
	Eggs	23	15	13	15	15	56	8	<1	<1	<0.1%
	Vegetation	77	72	70	23	40	-	227	4	1	0.1%

Table J-1
Kaktovik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[1]	Total Pounds[2]	Average HH Pounds	Per Capita Pounds	
1992b[3]	All Resources	-	-	-	-	-	-	180,970	-	-	100.0%
	Salmon	-	-	-	-	-	20	123	-	-	0.1%
	Non-Salmon Fish	-	66	-	-	-	19,641	32,941	-	-	18.2%
	Large Land Mammals	-	-	-	-	-	195	24,763	-	-	13.7%
	Small Land Mammals	-	-	-	-	-	51	13	-	-	<0.1%
	Marine Mammals	-	-	-	-	-	77	120,287	-	-	66.5%
	Migratory Birds	-	64	-	-	-	773	2,362	-	-	1.3%
	Upland Game Birds	-	-	-	-	-	400	257	-	-	0.1%
	Eggs	-	-	-	-	-	32	5	-	-	<0.1%
	Vegetation	-	50	-	-	-	56	219	-	-	0.1%
1994-95	All Resources	-	-	-	-	-	-	126,893	-	-	100.0%
	Salmon	-	-	-	-	-	1	6	-	-	<0.1%
	Non-Salmon Fish	-	-	-	-	-	4,425	7,934	-	-	6.3%
	Large Land Mammals	-	-	-	-	-	119	17,007	-	-	13.4%
	Small Land Mammals	-	-	-	-	-	59	18	-	-	<0.1%
	Marine Mammals	-	-	-	-	-	46	100,725	-	-	79.4%
	Migratory Birds	-	-	-	-	-	411	1,102	-	-	0.9%
	Upland Game Birds	-	-	-	-	-	119	119	-	-	0.1%
2002-03	All Resources	-	-	-	-	-	-	104,777	-	-	100.0%
	Non-Salmon Fish	-	-	-	-	-	2,363	4,784	-	-	4.6%
	Large Land Mammals	-	-	-	-	-	130	17,104	-	-	16.3%
	Small Land Mammals	-	-	-	-	-	56	20	-	-	<0.1%
	Marine Mammals	-	-	-	-	-	30	80,877	-	-	77.2%
	Migratory Birds	-	-	-	-	-	536	1,585	-	-	1.5%
	Upland Game Birds	-	-	-	-	-	370	370	-	-	0.4%
	Eggs	-	-	-	-	-	30	5	-	-	<0.1%
	Marine Invertebrates	-	-	-	-	-	3	6	-	-	<0.1%
	Vegetation	-	-	-	-	-	9	27	-	-	<0.1%
2007	All Resources	-	-	-	-	-	6,277	78,243	954	-	100.0%
	Salmon	-	-	-	-	-	5	14	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	5,086	7,592	93	-	9.7%
	Large Land Mammals	-	-	-	-	-	181	21,168	258	-	27.1%
	Small Land Mammals	-	-	-	-	-	31	14	<1	-	<0.1%
	Marine Mammals	-	-	-	-	-	17	47,316	577	-	60.5%
	Migratory Birds	-	-	-	-	-	537	1,814	22	-	2.3%
	Upland Game Birds	-	-	-	-	-	199	139	2	-	0.2%
	Bird Eggs	-	-	-	-	-	43	13	<1	-	<0.1%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	179	173	2	-	0.2%

Table J-1
Kaktovik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[1]	Total Pounds[2]	Average HH Pounds	Per Capita Pounds	
2008	All Resources	-	-	-	-	-	6,735	101,398	1,237	-	100.0%
	Salmon	-	-	-	-	-	11	34	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	5,364	12,000	146	-	11.8%
	Large Land Mammals	-	-	-	-	-	230	26,123	319	-	25.8%
	Small Land Mammals	-	-	-	-	-	47	2	<1	-	<0.1%
	Marine Mammals	-	-	-	-	-	23	60,731	741	-	59.9%
	Migratory Birds	-	-	-	-	-	698	2,274	28	-	2.2%
	Upland Game Birds	-	-	-	-	-	155	155	2	-	0.2%
	Bird Eggs	-	-	-	-	-	170	44	1	-	<0.1%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	36	36	<1	-	<0.1%
2009	All Resources	-	-	-	-	-	4,796	126,628	1,472	-	100.0%
	Salmon	-	-	-	-	-	4	14	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	3,737	7,919	92	-	6.3%
	Large Land Mammals	-	-	-	-	-	202	23,050	268	-	18.2%
	Small Land Mammals	-	-	-	-	-	54	8	<1	-	0.0%
	Marine Mammals	-	-	-	-	-	22	93,638	1,089	-	73.9%
	Migratory Birds	-	-	-	-	-	397	1,632	19	-	1.3%
	Upland Game Birds	-	-	-	-	-	287	287	3	-	0.2%
	Bird Eggs	-	-	-	-	-	0	0	0	-	0.0%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	93	82	1	-	0.1%
2010	All Resources	-	-	-	-	-	1,870	79,231	990	-	100.0%
	Salmon	-	-	-	-	-	4	16	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	1,195	762	10	-	1.0%
	Large Land Mammals	-	-	-	-	-	143	16,105	201	-	20.3%
	Small Land Mammals	-	-	-	-	-	19	3	<1	-	<0.1%
	Marine Mammals	-	-	-	-	-	12	61,474	768	-	77.6%
	Migratory Birds	-	-	-	-	-	151	596	7	-	0.8%
	Upland Game Birds	-	-	-	-	-	266	266	3	-	0.3%
	Bird Eggs	-	-	-	-	-	0	0	0	-	0.0%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	81	9	<1	-	<0.1%

Table J-1
Kaktovik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[1]	Total Pounds[2]	Average HH Pounds	Per Capita Pounds	
2010-11	All Resources	100	96	94	84	100	13,138	202,958	2,388	707	100.0%
	Salmon	19	7	6	9	14	59	288	3	1	0.1%
	Non- Salmon Fish	96	83	76	69	84	10,799	27,198	320	95	13.4%
	Large Land Mammals	94	56	47	51	93	511	68,458	805	239	33.7%
	Small Land Mammals	29	23	17	13	16	150	302	4	1	0.1%
	Marine Mammals	99	91	89	69	97	59	103,108	1,213	359	50.8%
	Migratory Birds	73	51	40	40	67	788	2,547	30	9	1.3%
	Upland Game Birds	60	43	37	29	40	710	710	8	3	0.4%
	Bird Eggs	1	1	1	1	0	7	5	0	0	0.0%
	Marine Invertebrates	1	0	0	0	1	0	0	0	0	0.0%
	Vegetation	46	29	19	21	41	55	342	4	1	0.2%
2011[4]	All Resources	-	-	-	-	-	8,216	98,841	1,236	-	100.0%
	Salmon	-	-	-	-	-	1	6	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	7,390	16,837	210	-	17.0%
	Large Land Mammals	-	-	-	-	-	191	21,920	274	-	22.2%
	Small Land Mammals	-	-	-	-	-	6	3	<1	-	<0.1%
	Marine Mammals	-	-	-	-	-	14	58,944	737	-	59.6%
	Migratory Birds	-	-	-	-	-	239	884	11	-	0.9%
	Upland Game Birds	-	-	-	-	-	127	127	2	-	0.1%
	Bird Eggs	-	-	-	-	-	65	18	<1	-	<0.1%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	183	102	1	-	0.1%
2012	All Resources	-	-	-	-	-	5,806	133,258	1,666	-	100.0%
	Salmon	-	-	-	-	-	7	32	<1	-	<0.1%
	Non- Salmon Fish	-	-	-	-	-	4,948	9,556	119	-	7.2%
	Large Land Mammals	-	-	-	-	-	169	20,099	251	-	15.1%
	Small Land Mammals	-	-	-	-	-	39	2	<1	-	<0.1%
	Marine Mammals	-	-	-	-	-	9	102,278	1,278	-	76.8%
	Migratory Birds	-	-	-	-	-	434	1,089	14	-	0.8%
	Upland Game Birds	-	-	-	-	-	0	0	0	-	0.0%
	Bird Eggs	-	-	-	-	-	0	0	0	-	0.0%
	Marine Invertebrates	-	-	-	-	-	-	-	-	-	-
	Vegetation	-	-	-	-	-	202	202	3	-	0.2%

Notes:
1. Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
2. Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
3. Due to a low response rate during the NSB 1992b survey, these data should be viewed with caution. Household participation for the 1992b study year based on Table A5 in Fuller and George (1999); participation in migratory bird harvests includes waterfowl and eggs; participation in vegetation harvests includes only berries; participation in non-salmon fish harvests is for

Table J-1
Kaktovik Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[1]	Total Pounds[2]	Average HH Pounds	Per Capita Pounds	

"fish" in general.
4. The survey in 2011 consisted of only an eight (8) month survey, covering May through December 2011. Therefore, estimates from 2011 may not be directly comparable with other years that covered an entire year.
The estimated harvest numbers for the 1994-95 and 2002-03 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2018)and total (usable) pounds for bowhead whales were calculated based on the method presented in (SRB&A and ISER 1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in (George, Philo, Suydam, Carroll, and Albert n.d.).
Sources: 1985, 1986 (ADF&G 2018); 1992a (Pedersen 1995a); 1992b (Fuller and George 1999); 1994-95 (Brower, Olemaun, and Hepa 2000); 2002-03 (Bacon, Hepa, Brower, Pederson, Olemaun, George, and Corrigan 2009); 2007-2012 (Harcharek, Kayotuk, George, and Pederson 2018); 2010-11 (Kofinas, BurnSilver, Magdanz, Stotts, and Okada 2016).
Stephen R. Braund & Associates, 2018

1

Table J-2
Kaktovik Subsistence Harvest Estimates by Resource Category, Non-Comprehensive Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest			
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Average HH Pounds	Per Capita Pounds
Non-Salmon Fish										
2000-01	Non-Salmon Fish	61	43	38	36	52	3,137	5,970	35	11
2001-02	Non-Salmon Fish	76	55	47	33	47	5,036	9,748	55	19

Sources: 2000-01, 2001-02 (Pedersen and Linn 2005)
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2

Table J-3
Kaktovik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[1]	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[2]	Total Pounds[3]	Average HH Pounds	Per Capita Pounds	
1981-82	Caribou	-	-	-	-	-	43	-	-	-	-
1982-83	Caribou	-	-	-	-	-	160	-	-	-	-
1983-84	Caribou	-	-	-	-	-	107	-	-	-	-
1985-86	Caribou	-	-	-	-	-	235	-	-	-	-

Table J-3
Kaktovik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[1]	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[2]	Total Pounds[3]	Average HH Pounds	Per Capita Pounds	
1985	Caribou	95	76	69	67	86	235	27,941	527	149	45.3%
	Arctic Char	100	86	81	41	69	3,075	8,611	162	46	14.0%
	Ringed Seal	69	50	45	26	45	151	6,360	120	34	10.3%
	Dall Sheep	79	29	21	21	74	47	4,622	87	25	7.5%
	Bearded Seal	62	43	33	29	57	21	3,776	71	20	6.1%
	Geese	71	62	57	38	43	647	2,913	55	15	4.7%
	Cisco	79	60	55	29	62	3,546	2,482	47	13	4.0%
	Moose	45	7	7	5	38	4	1,893	36	10	3.1%
	Muskox	43	5	2	2	43	1	748	14	4	1.2%
	Polar Bear	24	5	2	2	21	1	626	12	3	1.0%
	Ptarmigan	86	74	69	45	43	867	607	11	3	1.0%
1986	Bowhead Whale	96	62	43	51	94	-	43,704	780	225	52.0%
	Caribou	98	66	60	53	94	178	21,188	378	109	25.2%
	Arctic Char	94	70	70	62	77	1,768	4,951	88	25	5.9%
	Bearded Seal	75	34	26	23	64	17	2,936	52	15	3.5%
	Ringed Seal	72	40	38	28	60	44	1,851	33	10	2.2%
	Dall Sheep	75	15	9	9	68	17	1,710	31	9	2.0%
	Cisco	85	53	53	45	79	2,402	1,682	30	9	2.0%
	Muskox	68	4	4	4	66	2	1,413	25	7	1.7%
	Geese	83	55	51	36	70	371	1,410	25	7	1.7%
	Polar Bear	15	6	4	4	13	2	1,182	21	6	1.4%
1986-87	Caribou	-	-	-	-	-	201	-	-	-	-
1987-88	Caribou	-	-	55	-	-	185	22,229	383	104	-
1990[4]	Caribou	-	-	48	-	-	113	13,453	224	67	-
1991	Caribou	-	-	50	-	-	181	22,113	369	94	-
1992a	Bowhead Whale	87	53	6	62	85	-	108,160	1,717	560	63.3%
	Caribou	96	70	55	53	75	158	19,136	304	99	11.2%
	Arctic Char	92	81	79	66	45	5,523	15,463	245	80	9.0%
	Bering Cisco	77	62	62	57	45	8,103	5,672	90	29	3.3%
	Dall Sheep	70	36	28	32	64	44	4,379	70	23	2.6%
	Bearded Seal	75	47	28	32	60	24	4,246	67	22	2.5%
	Muskox	53	21	9	17	51	5	3,179	50	16	1.9%
	Geese	79	60	47	40	62	601	2,135	34	11	1.2%
	Moose	36	11	6	9	32	4	2,011	32	10	1.2%
	Ringed Seal	47	30	26	28	36	42	1,689	27	9	1.0%

Table J-3
Kaktovik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[1]	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[2]	Total Pounds[3]	Average HH Pounds	Per Capita Pounds	
1992b[5]	Bowhead Whale	-	59	-	-	-	3	108,463	-	-	59.9%
	Arctic Char	-	-	-	-	-	7,937	22,224	-	-	12.3%
	Caribou	-	66	-	-	-	136	15,926	-	-	8.8%
	Arctic Cisco	-	-	-	-	-	-	7,143	-	-	3.9%
	Dall Sheep	-	-	-	-	-	53	5,249	-	-	2.9%
	Walrus	-	23	-	-	-	5	3,737	-	-	2.1%
	Musk Ox	-	-	-	-	-	6	3,588	-	-	2.0%
	Bearded Seal	-	62	-	-	-	17	2,998	-	-	1.7%
	Beluga	-	-	-	-	-	2	2,761	-	-	1.5%
	Grayling	-	-	-	-	-	3,299	2,639	-	-	1.5%
	Geese	-	-	-	-	-	563	2,034	-	-	1.1%
1994-95	Bowhead Whale	-	-	-	-	-	3	88,688	-	-	69.9%
	Caribou	-	-	-	-	-	78	10,608	-	-	8.4%
	Bearded Seal	-	-	-	-	-	21	8,820	-	-	7.0%
	Dolly Varden	-	-	-	-	-	1,875	6,188	-	-	4.9%
	Dall Sheep	-	-	-	-	-	30	3,120	-	-	2.5%
	Muskox	-	-	-	-	-	9	2,655	-	-	2.1%
	Arctic Cisco	-	-	-	-	-	2,358	1,651	-	-	1.3%
2000-01	Dolly Varden	-	-	35	-	-	1,739	4,869	27	9	-
	Arctic Cisco	-	-	91	-	-	1,361	953	32	9	-
	Lake Trout	-	-	4	-	-	37	148	2	1	-
2001-02	Dolly Varden	-	-	44	-	-	2,649	7,418	41	14	-
	Arctic Cisco	-	-	38	-	-	2,187	1,531	19	7	-
	Lake Trout	-	-	6	-	-	200	800	10	3	-
2002-03	Bowhead Whale	-	-	-	-	-	3	75,515	-	-	72.1%
	Caribou	-	-	-	-	-	112	15,232	-	-	14.5%
	Arctic Char	-	-	-	-	-	1,162	3,834	-	-	3.7%
	Bearded Seal	-	-	-	-	-	8	3,360	-	-	3.2%
	Dall Sheep	-	-	-	-	-	18	1,872	-	-	1.8%
	Ringed Seal	-	-	-	-	-	17	1,258	-	-	1.2%
2007	Bowhead Whale	-	-	-	-	-	3	40,833	498	-	52.2%
	Caribou	-	-	-	-	-	181	21,168	258	-	27.1%
	Beluga Whale	-	-	-	-	-	6	5,934	72	-	7.6%
	Dolly Varden	-	-	-	-	-	1,658	4,643	57	-	5.9%
	Arctic Cisco	-	-	-	-	-	3,198	2,239	27	-	2.9%
2008	Bowhead Whale	-	-	-	-	-	3	57,482	701	-	56.7%
	Caribou	-	-	-	-	-	185	21,586	263	-	21.3%
	Dolly Varden	-	-	-	-	-	3,921	10,980	134	-	10.8%
	Dall Sheep	-	-	-	-	-	45	4,425	54	-	4.4%
	Polar Bear	-	-	-	-	-	3	1,662	20	-	1.6%
	Bearded Seal	-	-	-	-	-	6	1,117	14	-	1.1%

Table J-3
Kaktovik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[1]	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number[2]	Total Pounds[3]	Average HH Pounds	Per Capita Pounds	
2009	Bowhead Whale	-	-	-	-	-	3	88,488	1029	-	69.9%
	Caribou	-	-	-	-	-	170	19,872	231	-	15.7%
	Dolly Varden	-	-	-	-	-	2,449	6,857	80	-	5.4%
	Bearded Seal	-	-	-	-	-	15	2,915	34	-	2.3%
	Dall Sheep	-	-	-	-	-	29	2,886	34	-	2.3%
	Beluga Whale	-	-	-	-	-	2	1,450	17	-	1.1%
	White-Fronted Geese	-	-	-	-	-	274	1,234	14	-	1.0%
2010	Bowhead Whale	-	-	-	-	-	3	53,167	665	-	67.1%
	Caribou	-	-	-	-	-	115	13,458	168	-	17.0%
	Beluga Whale	-	-	-	-	-	8	8,075	101	-	10.2%
	Dall Sheep	-	-	-	-	-	16	1,612	20	-	2.0%
	Black Bear[6]	-	-	-	-	-	12	1,035	13	-	1.3%
2010-11	Bowhead	97	90	89	60	94	3	78,662	925	274	38.8%
	Caribou	94	53	46	51	93	429	58,305	686	203	28.7%
	Dolly Varden	94	79	76	64	77	6,333	20,898	246	73	10.3%
	Beluga	76	30	26	30	74	15	10,318	121	36	5.1%
	Bearded Seal	57	28	17	24	54	24	10,165	120	35	5.0%
	Dall Sheep	76	14	14	0	73	78	8,089	95	28	4.0%
	Broad Whitefish	43	26	20	20	29	1,148	3,729	44	13	1.8%
	Geese	70	49	40	37	60	701	2,272	27	8	1.1%
	Moose	16	9	4	4	13	4	1,960	23	7	1.0%
2011[7]	Bowhead Whale	-	-	-	-	-	3	57,661	721	-	58.3%
	Caribou	-	-	-	-	-	170	19,909	249	-	20.1%
	Dolly Varden	-	-	-	-	-	5,440	15,232	190	-	15.4%
	Dall Sheep	-	-	-	-	-	20	2,011	25	-	2.0%
	Bering Cisco	-	-	-	-	-	1,093	1,093	14	-	1.1%
	Bearded Seal	-	-	-	-	-	5	1,016	13	-	1.0%
2012	Bowhead Whale	-	-	-	-	-	3	100,968	1,262	-	75.8%
	Caribou	-	-	-	-	-	155	18,145	227	-	13.6%
	Dolly Varden	-	-	-	-	-	2,861	8,010	100	-	6.0%
2015	Caribou	-	52	-	-	-	303	35,451	-	-	-

Notes:
1. Except in the case of ducks and geese, which are lumped into more general species categories, this table shows individual species unless they are not available for a given study year.
2. Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
3. Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
4. Per capita pounds may be underestimated.
5. Data should be viewed with caution due to a low response rate. Household participation for the 1992b study year based on Table A5 in Fuller and George (1999). Bearded seal participation rates include all species of seal.
6. Probably misreported and should be brown bear (Akłaq).
7. The survey in 2011 consisted of only an eight (8) month survey, covering May through December 2011. Therefore, estimates from 2011 may not be directly comparable with other years that covered an entire year.
For All Resources study years (1985, 1986, 1992a, 1992b, 1994-95, 2002-03), species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0 percent of the total harvest; for single-resource study years,

Table J-3
Kaktovik Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource[1]	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number[2]	Total Pounds[3]	Average HH Pounds	Per Capita Pounds	% of Total Harvest

species are listed in descending order by total estimated pounds (or total number harvested, in the case of salmon study years) and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years).

The estimated harvest numbers for the 1994-95 and 2002-03 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at (ADF&G 2018) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in(George et al. n.d.).

Sources: 1981-82, 1982-83 (Pedersen and Coffing 1984); 1983-84 (Coffing and Pedersen 1985); 1985-86, 1986-87, 1987-88 (Pedersen 1990); 1985, 1986, 1990, 1991, (ADF&G 2018); 1992a (Pedersen 1995a); 1992b (Fuller and George 1999); 1994-95 (Brower et al. 2000); and 2000-01, 2001-02 (Pedersen and Linn 2005); 2002-03 (Bacon et al. 2009); 2007-2012 (Harcharek et al. 2018); 2010-11 (Kofinas et al. 2016); 2015 (SRB&A 2017a).

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J.1.2 Seasonal Round

Table J-4
Kaktovik Annual Cycle of Subsistence Activities

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Freshwater Non-Salmon	■	■	■	■	■	■	■	■	■	■	■	■
Marine Non-Salmon	■	■	■	■	■	■	■	■	■		■	■
Salmon							■	■	■			
Caribou	■	■	■	■	■	■	■	■	■	■	■	■
Moose	■	■	■	■			■	■	■	■	■	■
Bear					■		■	■	■	■	■	
Sheep	■		■	■				■	■	■	■	■
Muskox	■	■	■					■		■	■	■
Furbearers	■	■	■	■	■			■		■	■	■
Small Land Mammals			■	■	■	■		■	■		■	
Marine Mammals	■	■	■	■	■	■	■	■	■	■	■	■
Upland Birds			■	■	■	■	■	■		■	■	
Waterfowl				■	■	■	■	■	■	■		
Eggs				■	■	■	■	■	■	■		
Marine Invertebrates								■				
Plants and Berries							■	■	■			
Total Number of Resources Harvested	**8**	**7**	**10**	**11**	**10**	**8**	**11**	**16**	**12**	**11**	**11**	**8**

■ Subsistence activity

Sources: 2002-03 (Bacon et al. 2009); 1994-95 (Brower et al. 2000); 2004 (EDAW Inc., Consulting, Research, Callaway, Associates, and Economics 2008); 1992 (Fuller and George 1999); (Kofinas et al. 2016); pre-1989 (Pedersen, Haynes, and Wolfe 1991); 2000-01 (Pedersen and Linn 2005); 1996-2006 (SRB&A 2010); 2007-2012 (Harcharek et al. 2018);.

J.1.3 Travel Method

Table J-5
Kaktovik Travel Method to Subsistence Use Areas

Resources	Boat	Snowmachine	Foot	Car/Truck	ATV
Arctic Cisco					
Burbot					
Arctic Char/Dolly Varden & Broad Whitefish					
Broad Whitefish					
Caribou					
Moose					
Wolf & Wolverine					
Bowhead Whale					
Seals					
Walrus					
Geese					
Eider					
Total Number of Resources Targeted	**12**	**9**	**7**	**3**	**6**

Notes: For each resource, darker shades indicate greater use of that travel method - lighter shades indicate lesser use of a travel method.
Sources: 1996-2006 (SRB&A 2010)

J.1.4 Resource Importance

Table J-6
Material and Cultural Importance of Subsistence Resources, Kaktovik

Resource	Cultural Importance		Material Importance
	% of Households		% of Total Harvest
	Try to Harvest	Receive	
Major Resources			
Bearded Seal	38	59	2.6%
Bering Cisco	62	45	2.2%
Bowhead Whale	62	89	56.6%
Caribou	66	93	21.6%
Dall Sheep	24	70	2.9%
Dolly Varden/Arctic Char	79	67	7.4%
Ptarmigan	60	47	0.4%
Wood	64	21	-
Moderate Resources			
Arctic Cisco	17	16	1.2%
Arctic Fox	14	1	-
Arctic Grayling	11	13	0.2%
Belukha/Beluga	12	38	2.6%
Blueberry	20	22	<.1%

Table J-6
Material and Cultural Importance of Subsistence Resources, Kaktovik

Resource	Cultural Importance		Material Importance
	% of Households		% of Total Harvest
	Try to Harvest	Receive	
Broad Whitefish	8	25	0.3%
Canada Geese	48	46	0.3%
Common Eider	19	15	0.1%
Cranberry	21	33	0.1%
King Eider	13	10	<.1%
Lake Trout	13	24	0.3%
Least Cisco	9	13	0.1%
Long-tailed Duck (Oldsquaw)	22	17	<.1%
Moose	8	37	1.3%
Muskox	8	40	1.5%
Polar Bear	4	12	0.8%
Ringed Seal	38	36	1.5%
Saffron Cod	16	1	<.1%
Salmonberry/Cloudberry	21	33	0.1%
Snow Geese	17	9	<.1%
Squirrel	28	16	0.1%
Walrus	8	31	0.6%
Whitefronted Geese	30	26	0.5%
Wolf	11	2	-
Wolverine	13	2	-
Minor Resources			
Bird Eggs	6	6	<.1%
Brown Bear	3	6	0.2%
Halibut	1	9	0.2%
Humpback Whitefish	-	5	<.1%
Red Fox	9	1	-
Spotted Seal	9	5	0.2%

[1] For space considerations, resources contributed an average of less than 1 percent of harvest, less than 5 percent attempting harvests, and less than 5 percent receiving harvests are categorized as minor and are not be shown.
[2] Major resources contribute > 9 percent total harvest, have ≥ 50 percent of households attempting harvest, or have ≥ 50 percent of households receiving resource.
[3] Moderate resources contribute 2 to 9 percent of total harvest, have 11 to 49 percent of households attempting harvest, or have 11 to 49 percent of households receiving resource.
[4] Minor resources contribute < 2 percent of total harvest, have ≤ 10 percent of households attempting harvest, or have ≤ 10 percent of households receiving resource.
[5] Averages include unsuccessful bowhead whale harvest years.
Sources: 1981-82, 1982-83 (Pedersen and Coffing 1984); 1983-84 (Coffing and Pedersen 1985); 1985-86, 1986-87, 1987-88 (Pedersen 1990); 1985, 1986, 1990, 1991, (ADF&G 2018); 1992a (Pedersen 1995a); 1992b (Fuller and George 1999); 1994-95 (Brower et al. 2000); and 2000-01, 2001-02 (Pedersen and Linn 2005); 2002-03 (Bacon et al. 2009); 2007-2012 (Harcharek et al. 2018); 2010-11 (Kofinas et al. 2016); 2015 (SRB&A 2017a).

J.2 NUIQSUT

J.2.1 Harvest Data

Table J-7
Nuiqsut Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
1985	All Resources	100	98	98	95	100	-	160,035	2,106	399	100.0%
	Salmon	60	43	40	23	23	441	1,366	18	3	0.9%
	Non-Salmon Fish	100	93	93	83	75	67,712	69,243	911	173	43.3%
	Large Land Mammals	98	90	90	80	70	536	67,621	890	169	42.3%
	Small Land Mammals	65	63	58	23	13	688	245	3	1	0.2%
	Marine Mammals	100	48	23	30	100	59	13,355	176	33	8.3%
	Migratory Birds	90	90	85	60	55	1,733	6,626	87	17	4.1%
	Upland Game Birds	88	88	88	58	13	1,957	1,370	18	3	0.9%
	Bird Eggs	25	25	23	8	10	262	40	1	<1	<0.1%
	Vegetation	38	50	18	10	20	-	169	2	<1	0.1%
1992***	All Resources	-	-	-	-	-	-	150,195	-	-	100.0%
	Salmon	-	-	-	-	-	6	65	-	-	0.0%
	Non-Salmon Fish	-	74	-	-	-	36,701	51,890	-	-	34.5%
	Large Land Mammals	-	-	-	-	-	299	41,386	-	-	27.6%
	Small Land Mammals	-	-	-	-	-	46	1	-	-	0.0%
	Marine Mammals	-	-	-	-	-	49	52,865	-	-	35.2%
	Migratory Birds	-	-	-	-	-	1,105	3,655	-	-	2.4%
	Upland Game Birds	-	-	-	-	-	378	265	-	-	0.2%
	Eggs	-	-	-	-	-	25	4	-	-	<0.1%
	Vegetation	-	32	-	-	-	-	66	-	-	<0.1%
1993	All Resources	100	94	90	92	98	-	267,818	2,943	742	100.0%
	Salmon	71	45	36	39	47	272	1,009	11	3	0.4%
	Non-Salmon Fish	97	79	79	87	90	71,626	89,481	983	248	33.4%
	Large Land Mammals	98	76	74	82	92	691	87,306	959	242	32.6%
	Small Land Mammals	53	45	42	27	18	599	84	1	<1	<0.1%
	Marine Mammals	97	58	37	79	97	113	85,216	936	236	31.8%
	Migratory Birds	87	74	73	63	65	2,238	3,540	39	10	1.3%
	Upland Game Birds	60	45	45	42	26	973	681	7	2	0.3%
	Eggs	40	21	19	15	23	346	104	1	<1	<0.1%
	Vegetation	79	71	71	27	40	-	396	4	1	0.1%
1994-95****	All Resources	-	-	-	-	-	-	83,228	-	-	100.0%
	Salmon	-	-	-	-	-	10	31	-	-	<0.1%
	Non-Salmon Fish	-	-	-	-	-	15,190	46,569	-	-	56.0%
	Large Land Mammals	-	-	-	-	-	263	32,686	-	-	39.3%
	Small Land Mammals	-	-	-	-	-	42	0	-	-	0.0%
	Marine Mammals	-	-	-	-	-	25	1,504	-	-	1.8%
	Migratory Birds	-	-	-	-	-	569	2,289	-	-	2.8%
	Upland Game Birds	-	-	-	-	-	58	58	-	-	0.1%
	Vegetation	-	-	-	-	-	14	91	-	-	0.1%

Table J-7
Nuiqsut Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	% of Total Harvest
1995-96	All Resources	-	-	-	-	-	-	183,576	-	-	100.0%
	Salmon	-	-	-	-	-	42	131	-	-	0.1%
	Non-Salmon Fish	-	-	-	-	-	10,612	16,822	-	-	9.2%
	Large Land Mammals	-	-	-	-	-	364	43,554	-	-	23.7%
	Small Land Mammals	-	-	-	-	-	27	0	-	-	0.0%
	Marine Mammals	-	-	-	-	-	178	120,811	-	-	65.8%
	Migratory Birds	-	-	-	-	-	683	2,166	-	-	1.2%
	Upland Birds	-	-	-	-	-	19	13	-	-	<0.1%
	Vegetation	-	-	-	-	-	12	78	-	-	<0.1%
2000-01	All Resources	-	-	-	-	-	-	183,246	-	-	100.0%
	Salmon	-	-	-	-	-	10	75	-	-	<0.1%
	Non-Salmon Fish	-	-	-	-	-	26,545	27,933	-	-	15.2%
	Large Land Mammals	-	-	-	-	-	504	62,171	-	-	33.9%
	Small Land Mammals	-	-	-	-	-	108	2	-	-	<0.1%
	Marine Mammals	-	-	-	-	-	31	87,929	-	-	48.0%
	Migratory Birds	-	-	-	-	-	1,192	5,108	-	-	2.8%
	Upland Birds	-	-	-	-	-	23	16	-	-	<0.1%
	Vegetation	-	-	-	-	-	2	13	-	-	<0.1%
2014	All Resources	100	95	90	91	97	-	371,992	3,444	896	100.0%
	Salmon	64	41	40	31	35	-	3,889	36	9	1.0%
	Non-Salmon Fish	93	78	71	72	71	-	85,106	788	205	22.9%
	Large Land Mammals	91	66	64	67	72	-	108,359	1,003	261	29.1%
	Small Land Mammals	17	16	10	2	7	-	0	0	0	0.0%
	Marine Mammals	95	55	40	71	95	-	169,367	1,568	408	45.5%
	Migratory Birds	79	71	66	52	38	-	4,742	44	11	1.3%
	Upland Birds	16	12	12	9	5	-	78	1	<1	<0.1%
	Vegetation	67	55	53	21	38	-	414	4	1	0.1%

Notes: *Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
**Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
***The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George 1999).
****The 1994-95 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994-95.
The estimated harvest numbers for the 1994-95, 1995-96 and 2000-01 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2018) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in (George et al. n.d.).
Sources: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995b); 1994-95 (Brower and Hepa 1998); 1995-96, 2000-01 (Bacon et al. 2009); 2014 (Brown, Braem, Mikow, Trainor, Slayton, Runfola, Ikuta, Kostick, McDevitt, Park, and Simon 2016).
Stephen R. Braund & Associates, 2018.

Table J-8
Nuiqsut Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
1985	Caribou	98	90	90	80	60	513	60,021	790	150	37.5%
	Cisco	98	75	73	65	60	46,478	29,354	386	73	18.3%
	Broad Whitefish	95	80	78	70	40	7,900	26,861	353	67	16.8%
	Bowhead Whale	100	23	5	8	100	0	7,458	98	19	4.7%
	Moose	40	40	18	20	25	13	6,650	88	17	4.2%
	White-fronted Geese	90	90	85	55	48	1,340	6,028	79	15	3.8%
	Arctic Grayling	78	65	63	48	35	4,055	3,650	48	9	2.3%
	Humpback Whitefish	48	45	38	33	13	4,345	3,476	46	9	2.2%
	Arctic Char	75	63	60	33	35	1,060	2,969	39	7	1.9%
	Burbot	75	60	60	43	33	669	2,675	35	7	1.7%
	Bearded Seal	48	25	15	15	35	15	2,675	35	7	1.7%
	Ringed Seal	53	25	18	23	40	40	1,676	22	4	1.0%
1992	Bowhead Whale	-	-	-	-	-	2	48,715	-	-	32.4%
	Caribou	-	81	-	-	-	278	32,551	-	-	21.7%
	Arctic Cisco	-	-	-	-	-	22,391	22,391	-	-	14.9%
	Broad Whitefish	-	-	-	-	-	6,248	15,621	-	-	10.4%
	Moose****	-	-	-	-	-	18	8,835	-	-	5.9%
	Humpback Whitefish	-	-	-	-	-	1,802	4,504	-	-	3.0%
	Arctic Char	-	-	-	-	-	1,544	4,324	-	-	2.9%
	Bearded Seal	-	-	-	-	-	16	2,760	-	-	1.8%
	Arctic Grayling	-	-	-	-	-	3,114	2,491	-	-	1.7%
	Canada Geese	-	-	-	-	-	319	1,437	-	-	1.0%
1993	Caribou	98	74	74	79	79	672	82,169	903	228	30.7%
	Bowhead Whale	97	37	5	76	97	3	76,906	845	213	28.7%
	Broad Whitefish	90	66	66	65	66	12,193	41,455	456	115	15.5%
	Arctic Cisco	89	69	68	81	60	45,237	31,666	348	88	11.8%
	Ringed Seal	65	42	31	40	55	98	7,277	80	20	2.7%
	Burbot	79	63	57	53	55	1,416	5,949	65	16	2.2%
	Moose	69	47	10	29	63	9	4,403	48	12	1.6%
	Arctic Grayling	79	69	65	44	27	4,515	4,063	45	11	1.5%
	Least Cisco	63	52	47	36	27	6,553	3,277	36	9	1.2%
1994-95*****	Broad Whitefish	-	-	-	-	-	3,237	37,417	-	-	45.0%
	Caribou	-	-	-	-	-	258	30,186	-	-	36.3%
	Arctic Cisco	-	-	-	-	-	9,842	6,889	-	-	8.3%
	Moose	-	-	-	-	-	5	2,500	-	-	3.0%
	Geese Unidentified	-	-	-	-	-	474	2,133	-	-	2.6%
	Ringed Seal	-	-	-	-	-	24	1,008	-	-	1.2%
1995-96	Bowhead Whale	-	-	-	-	-	4	110,715	-	-	60.3%
	Caribou	-	-	-	-	-	362	42,354	-	-	23.1%
	Broad Whitefish	-	-	-	-	-	2,863	9,735	-	-	5.3%
	Ringed Seal	-	-	-	-	-	155	6,527	-	-	3.6%
	Arctic Cisco	-	-	-	-	-	5,030	3,521	-	-	1.9%
	Bearded Seal	-	-	-	-	-	17	2,974	-	-	1.6%
	Least Cisco	-	-	-	-	-	1,804	1,804	-	-	1.0%

Table J-8
Nuiqsut Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
1999-00	Caribou	-	-	-	-	-	413	-	-	112	-
2000-01	Bowhead Whale	-	-	-	-	-	4	86220	-	-	47.1%
	Caribou	-	-	-	-	-	496	57,985	-	-	31.6%
	Arctic Cisco	-	-	-	-	-	18,222	12,755	-	-	7.0%
	Broad Whitefish	-	-	-	-	-	2,968	10,092	-	-	5.5%
	White-fronted Geese	-	-	-	-	-	787	3,543	-	-	1.9%
	Moose	-	-	-	-	-	6	3,000	-	-	1.6%
2002-03	Caribou	95	47	45	49	80	397	-	-	118	-
2003-04	Caribou	97	74	70	81	81	564	-	-	157	-
2004-05	Caribou	99	62	61	81	96	546	-	-	147	-
2005-06	Caribou	100	60	59	97	96	363	-	-	102	-
2006-07	Caribou	97	77	74	66	69	475	-	-	143	-
2010	Caribou	94	86	76	-	-	562	65,754	707	-	-
2011	Caribou	92	70	56	49	58	437	51,129	544	134	-
2012	Caribou	99	68	62	65	79	501	58,617	598	147	-
2013	Caribou	95	79	63	62	75	586	68,534	692	166	-
2014	Bowhead	93	29	21	57	91	5	148,087	1,371	357	39.8%
	Caribou	90	66	64	67	59	774	105,193	974	253	28.3%
	Broad Whitefish	72	60	59	52	40	11,439	36,605	339	88	9.8%
	Arctic Cisco	83	52	48	59	53	46,277	32,394	300	78	8.7%
	Bearded Seal	67	38	22	40	62	13,846	13,846	128	33	3.7%
	Least Cisco	33	28	28	19	7	13,332	9,333	86	22	2.5%
	Ringed Seal	52	40	35	38	33	108	6,156	57	15	1.7%
2015	Caribou	96	84	78	74	72	628	73,527	728	180	-

Notes: *This table shows individual species unless they are not available for a given study year.
**Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
***Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
****The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George 1999).
*****The 1994-95 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994-95.
For All Resources study years (1985, 1992, 1993, 1994-95, 1995-96, 2000-01), species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0 percent of the total harvest; for single-resource study years, species are listed in descending order by total estimated pounds (or total number harvested, in the case of salmon study years) and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years.
The estimated harvest numbers for the 1992, 1994-95, 1995-96 and 2000-01 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2018) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in (George et al. n.d.). For the 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, 2010, and 2011 study years, total pounds were derived from conversion rates from (Braem, Kaleak, Koster, Leavitt, Neakok, Patkotak, Pedersen, and Simon 2011)
Sources: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995b); 1994-95 (Brower and Hepa 1998); 1995-96, 2000-01 (Bacon et al. 2009); 1999-00, 2002-2007 (Braem et al. 2011); 2010, 2011, 2012, 2013 (SRB&A 2012, 2013, 2014, 2015); 2014 (Brown et al. 2016); 2015 (SRB&A 2017b).
Stephen R. Braund & Associates, 2018.

J.2.2 Seasonal Round

Table J-9
Nuiqsut Annual Cycle of Subsistence Activities

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Freshwater Non-Salmon												
Marine Non-Salmon												
Salmon												
Caribou												
Moose												
Bear												
Muskox												
Furbearers												
Small Land Mammals												
Marine Mammals												
Upland Birds												
Waterfowl												
Eggs												
Plants and Berries												
Total # of Resources Harvested	**6**	**5**	**6**	**7**	**9**	**10**	**10**	**12**	**11**	**10**	**8**	**8**

Limited activity and/or harvests; Moderate activity and/or harvests; High activity and/or harvests

Sources: 1995-96, 2000-01 (Bacon et al. 2009); 2002-2007 (Braem et al. 2011); 1994-95 (Brower and Hepa 1998); Pre-1979 (Brown 1979); 2014 (Brown et al. 2016); 2004 (EDAW Inc. et al. 2008); 1992 (Fuller and George 1999); 2001-2012 (Galginaitis 2014); 1988 (Hoffman, Libbey, and Spearman 1988); 1979 (Libbey, Spearman, and Hoffman 1979); 1995-2006 (SRB&A 2010); 2008-2015 (SRB&A 2017b).

J.2.3 Travel Method

Table J-10
Nuiqsut Travel Method to Subsistence Use Areas

Resources	Boat	Snowmachine	Foot	Car/Truck	ATV	Plane
Arctic Cisco & Burbot						
Arctic Char/Dolly Varden & Broad Whitefish						
Caribou						
Moose						
Wolf & Wolverine						
Bowhead Whale						
Seals						
Geese						
Eider						
Total Number of Resources Targeted	**9**	**7**	**4**	**3**	**2**	**1**

Notes: For each resource, darker shades indicate greater use of that travel method - lighter shades indicate lesser use of a travel method. Caribou based on SRB&A 2017. All others based on SRB&A 2010a.
Sources: 1995-2006 (SRB&A 2010), 2008-2015 (SRB&A 2017b).

J.2.4 Resource Importance

Table J-11
Material and Cultural Importance of Subsistence Resources, Nuiqsut

Resource	Cultural Importance		Material Importance
	% of Households		% of Total Harvest
	Trying to Harvest	Receiving	
Major Resources[2]			
Arctic Cisco	61	57	8.8%
Arctic Grayling	50	24	1.0%
Bearded Seal	32	50	1.6%
Bowhead Whale	30	96	30.4%
Broad Whitefish	69	49	15.5%
Burbot	51	35	1.0%
Caribou	73	75	29.9%
Cloudberry	55	29	0.0%
White Fronted Geese	62	36	1.4%
Wood	50	3.2	0.0%
Moderate Resources[3]			
Arctic Char	38	22	0.9%
Arctic Fox	14	1	0.0%
Beluga	2	24	0.0%
Bird Eggs	16	12	0.0%
Blueberries	29	16	0.0%
Brant	17	9	0.1%
Brown Bear	14	18	0.2%
Canada Geese	42	24	0.4%

Table J-11
Material and Cultural Importance of Subsistence Resources, Nuiqsut

Resource	Cultural Importance % of Households		Material Importance % of Total Harvest
	Trying to Harvest	Receiving	
Chum Salmon	23	11	0.6%
Ground Squirrel	45	8	0.1%
Humpback Whitefish	26	9	1.0%
King Eider	24	19	0.0%
Least Cisco	40	17	1.1%
Long-Tailed Duck	8	13	0.0%
Moose	40	41	2.5%
Pink Salmon	28	17	0.4%
Polar Bear	7	29	0.2%
Ptarmigan	48	15	0.2%
Rainbow Smelt	13	22	0.1%
Red Fox	22	2	0.0%
Ringed Seal	36	43	1.6%
Snow Geese	19	7	0.0%
Spotted Seal	13	5	0.1%
Walrus	7	43	0.2%
Wolf	18	6	0.0%
Wolverine	22	5	0.0%
Minor Resources[4]			
Arctic Cod	7	7	0.0%
Chinook Salmon	2	9	0.0%
Coho Salmon	3	5	0.0%
Common Eider Duck	7	3	0.1%
Cranberries	9	5	0.0%
Crowberries	7	2	0.0%
Dall Sheep	-	9	0.0%
Dolly Varden	10	3	0.4%
Lake Trout	3	8	0.0%
Muskox	-	8	0.3%
Northern Pike	7	7	0.0%
Northern Pintail	5	1.6	0.0%
Round Whitefish	5	1	0.1%
Saffron Cod	7	-	0.0%
Sheefish	-	6	0.0%
Sockeye Salmon	3	6	0.0%
Sourdock	5	7	0.0%
Weasel	5	-	0.0%

[1] For space considerations, resources contributed an average of less than 1 percent of harvest, less than 5 percent attempting harvests, and less than 5 percent receiving harvests are categorized as minor and are not be shown.
[2] Major resources contribute > 9 percent total harvest, have ≥ 50 percent of households attempting harvest, or have ≥ 50 percent of households receiving resource.
[3] Moderate resources contribute 2 to 9 percent of total harvest, have 11 to 49 percent of households attempting harvest, or have 11 to 49 percent of households receiving resource.
[4] Minor resources contribute < 2 percent of total harvest, have ≤ 10 percent of households attempting harvest, or have ≤ 10 percent of households receiving resource.
[5] Averages include unsuccessful bowhead whale harvest years.
Sources: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995b); 1994-95 (Brower and Hepa 1998); 1995-96, 2000-01 (Bacon et al. 2009); 1999-00, 2002-2007 (Braem et al. 2011); 2010, 2011, 2012, 2013 (SRB&A 2012, 2013, 2014, 2015); 2014 (Brown et al. 2016); 2015 (SRB&A 2017).

J.3 ARCTIC VILLAGE

J.3.1 Harvest Data

Table J-12
Arctic Village Subsistence Harvest Estimates by Resource Category, Non-Comprehensive Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest			
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Average HH Pounds	Per Capita Pounds
Migratory Birds										
2000	Migratory Birds	87	46	52	37	39	437	820	16	6
Non-Salmon Fish										
2001	Non-Salmon Fish	63	-	63	24	28	4,754	9,923	102	34
Non-Salmon Fish										
2002	Non-Salmon Fish	80	-	42	21	42	7,676	18,416	181	67

Sources: 2000 (Andersen and Jennings 2001); 2001-02, 2002-03 (Adams, Tanner, and Nelson 2005)
Stephen R. Braund & Associates, 2018.

Table J-13
Arctic Village Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
2000	Scoter	-	-	-	-	-	187	370	7	3	-
	Scaup	-	-	-	-	-	71	118	2	1	-
	Long-tailed Duck (Oldsquaw)	-	-	-	-	-	67	100	2	1	-
	Mallard	-	-	-	-	-	49	95	2	1	-
	White-fronted Geese	-	-	-	-	-	10	43	1	<1	-
2001	Broad Whitefish	12	-	12	8	5	990	3,958	39	14	-
	Humpback Whitefish	17	-	17	10	7	1,685	3,538	38	12	-
	Grayling	47	-	47	13	20	1,257	1,257	13	4	-
	Northern Pike	18	-	18	7	5	187	562	6	2	-
	Lake Trout	9	-	9	2	0	212	212	4	1	-
2002	Humpback Whitefish	28		10	4	20	3,987	8,373	84	30	-
	Broad Whitefish	40		16	10	26	1,673	6,691	65	24	-
	Northern Pike	20		18	11	2	598	1,793	18	7	-
	Grayling	32		29	8	5	857	857	9	3	-
	Unknown Whitefish	2		1	0	1	188	328	3	1	-

Notes: For single-resource study years, species are listed in descending order by total estimated pounds and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years.
Sources: 2000 (Andersen and Jennings 2001); 2001-02, 2002-03 (Adams et al. 2005)
Stephen R. Braund & Associates, 2018.

J.3.2 Seasonal Round

Table J-14
Arctic Village Annual Cycle of Subsistence Activities

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fish			■	■	■	■	□	■		■	■	
Caribou	■	■	■					■	■	■	■	■
Moose	□	□	■						■	□	□	□
Sheep								□	■		■	□
Furbearers	■	■	■								■	■
Small Land Mammals	□	■	■	■	■			□	■	■	■	■
Waterfowl					■	□	□	□	□			
Vegetation (Wood)	■	■	■	□	□	□	□	□	■	■	■	■
Total Number of Resources Harvested	**5**	**5**	**6**	**3**	**4**	**3**	**3**	**6**	**6**	**5**	**7**	**6**

□ Low to medium levels of activity; ■ High levels of activity
Sources: 1970-82 (Caulfield 1983); 2000 (Andersen and Jennings 2001).

J.3.3 Resource Importance

Data to calculate resources of importance for Arctic Village are not available, as there have been no comprehensive household harvest surveys conducted for that community. However, based on existing literature and statements from community members during scoping and elsewhere, it can be assumed that caribou, among other resources, is a resource of major material and cultural importance for the community of Arctic Village.

J.4 VENETIE

J.4.1 Harvest Data

Table J-15
Venetie Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
2009	All Resources	99	86	81	-	-	13344	74602	794	274	100.0%
	Salmon	76	37	26	-	-	2742	20775	221	76	27.8%
	Non-Salmon Fish	81	67	63	-	-	6348	6745	72	25	9.0%
	Large Land Mammals	94	63	33	-	-	159	36977	393	136	49.6%
	Small Land Mammals	56	44	43	-	-	1632	3126	33	12	4.2%
	Marine Mammals	18	0	0	-	-	0	0	0	0	0.0%
	Migratory Birds	79	57	55	-	-	2134	5501	59	20	7.4%
	Upland Game Birds	20	31	16	-	-	119	119	1	0	0.2%
	Vegetation	67	46	43	-	-	210	1360	15	5	1.8%

2009 (Kofinas et al. 2016)
Stephen R. Braund & Associates, 2018.

Table J-16
Venetie Subsistence Harvest Estimates by Resource Category, Non-Comprehensive Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest			
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Average HH Pounds	Per Capita Pounds
Migratory Birds										
2000	Migratory Birds			68			2,077	3,306	94	25

Sources: 2000 (Andersen and Jennings 2001)
Stephen R. Braund & Associates, 2018.

Table J-17
Venetie Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
2000	Unknown Scoter	-	-	-	-	-	1,354	1,354	39	10	-
	White-fronted Geese	-	-	-	-	-	150	638	18	5	-
	Canada Geese	-	-	-	-	-	153	609	17	5	-
	Long-tailed Duck (Oldsquaw)	-	-	-	-	-	217	326	9	2	-
	Mallard	-	-	-	-	-	65	122	3	1	-
2008-09	Moose	95	51	32	68	92	22	12,060	-	80	-
	Caribou	98	18	18	65	92	16	2,135	-	14	-
	Black Bear	14	11	6	3	6	5	532	-	4	-
	Brown Bear	5	8	2	0	2	1	150	-	1	-
	Lynx	3	3	3	2	0	1	-	-	-	-
2009	Moose	93	61	30	60	87	40	21,476	229	79	28.8%
	Caribou	86	23	14	49	85	105	14,230	151	52	19.1%
	Chum Salmon	42	27	20	12	30	2,066	12,395	132	46	16.6%
	Chinook Salmon	69	27	16	26	62	675	8,374	89	31	11.2%
	Arctic Grayling	80	66	62	44	49	5,492	4,943	53	18	6.6%
	Geese	68	45	37	36	56	969	3,142	33	12	4.2%
	Whitefishes	41	13	8	12	40	853	1,791	19	7	2.4%
	Beaver	26	15	14	14	15	65	1,298	14	5	1.7%
	Snowshoe Hare	43	36	35	21	16	574	1,148	12	4	1.5%
	Black Bear	19	17	8	6	12	10	886	9	3	1.2%
2009-10	Moose	53	41	13	36	50	24	16,548	-	86	-
	Caribou	39	13	5	25	39	6	556	-	3	-
	Black Bear	8	5	5	2	5	4	417	-	2	-
	Brown Bear	3	2	2	2	2	1	196	-	1	-
	Lynx	3	3	3	2	2	86	-	-	-	-
2010-11	Moose	-	35	9	11	14	5	2,916	-	16	-
	Caribou	-	30	15	16	10	44	6,615	-	37	-
	Lynx	-	0	0	0	9	0	-	-	-	-
	Marten	-	0	0	0	4	0	-	-	-	-

Notes:
For All Resources study years (2009), species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0 percent of the total harvest; for single-resource study years, species are listed in descending order by total estimated pounds and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years.
Sources: 2000 (ADF&G 2018); 2008-09, 2009-10 (Van Lanen, Stevens, Brown, Maracle, and Koster 2012); 2009 (Kofinas et al. 2016); 2010-11 (Stevens and Maracle n.d.)
Stephen R. Braund & Associates, 2018.

J.4.2 Seasonal Round

Table J-18
Venetie Annual Cycle of Subsistence Activities

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fish			■	■	■	■	■	■	■			
Caribou	■	■	■	■				■	■		■	■
Moose	■	■	■					■	■	■	■	■
Bear				■	■	■	■	■	■			
Furbearers	■	■	■								■	■
Small Land Mammals				■	■	■						
Waterfowl				■	■	■	■	■	■			
Berries							■	■	■			
Wood	■	■	■	■	■	■	■	■	■	■	■	■
Total Number of Resources Harvested	**4**	**4**	**5**	**6**	**5**	**5**	**5**	**7**	**7**	**2**	**4**	**4**

■ Subsistence activity and/or harvests

Sources: 2000 (Andersen and Jennings 2001); 1970-82 (Caulfield 1983); Kofinas et al. 2016; 2008-09, 2009-10 (Van Lanen et al. 2012); 2010-11 (Stevens and Maracle n.d.).

J.4.3 Resource Importance

Table J-19
Material and Cultural Importance of Subsistence Resources, Venetie

Resource	Cultural Importance		Material Importance
	% of Households		% of Total Harvest
	Trying to Harvest	Receive	
Major Resources			
Arctic grayling	66	49	6.6%
Caribou	21	56	19.1%
Chinook Salmon	27	62	11.2%
Chum Salmon	27	30	16.6%
Moose	47	61	28.8%
Moderate Resources			
Bearded seal	0	15	-
Beaver	15	15	1.7%
Black Bear	11	8	1.2%
Blueberry	41	49	0.9%
Bowhead	0	15	-
Low Bush Cranberry	35	30	0.8%
Muskrat	11	10	0.5%
Other Birds	31	8	0.2%
Parka Squirrel (ground)	10	12	0.2%
Ptarmigan	27	8	0.1%
Snowshoe hare	18	8	1.5%
Whitefishes	13	40	2.4%
Minor Resources			
Beluga	0	6	-
Brown Bear	6	1	0.5%
Grouse	7	2	-

[1] For space considerations, resources contributed an average of less than 1 percent of harvest, less than 5 percent attempting harvests, and less than 5 percent receiving harvests are categorized as minor and are not be shown.
[2] Major resources contribute > 9 percent total harvest, have ≥ 50 percent of households attempting harvest, or have ≥ 50 percent of households receiving resource.
[3] Moderate resources contribute 2 to 9 percent of total harvest, have 11 to 49 percent of households attempting harvest, or have 11 to 49 percent of households receiving resource.
[4] Minor resources contribute < 2 percent of total harvest, have ≤ 10 percent of households attempting harvest, or have ≤ 10 percent of households receiving resource.
Sources: 2000 (ADF&G 2018); 2008-09, 2009-10 (Van Lanen et al. 2012); 2009 (Kofinas et al. 2016); 2010-11 (Stevens and Maracle n.d.)

J.5 CARIBOU STUDY COMMUNITIES

Table J-20
Caribou Harvest Data for All Available Study Years, Caribou Study Communities

Community	Study Year	% of HHs					Estimated Harvest				Percent of Total Harvest
		Using	Trying to Harvest	Harvesting	Giving	Receiving	Total Number	Total Pounds	Average HH Lbs	Per Capita Lbs	
Alatna	1997-98	73	46	36	36	46	21	2,730	248	109	
	1998-99	100	90	60	50	60	11	1,430	143	53	
	1999-00	100	57	0	0	100	0	-	0	0	
	2001-02	27	0	0	0	27	0	-	0	0	
	2002-03	100	67	67	50	83	34	4,420	368	123	
	2011	100	83	67	67	100	28	3,705	412	118	39.3%
	Average	***83***	***57***	***38***	***34***	***69***	***16***	***2,048***	***195***	***67***	***39.3%***
Allakaket	1997-98	42	15	6	10	39	11	1,375	25	8	-
	1998-99	100	55	26	20	86	43	5,623	92	29	-
	1999-00	93	34	12	15	86	13	1,719	29	10	-
	2001-02	21	7	7	3	15	9	1,170	19	7	-
	2002-03	96	68	44	32	68	106	13,728	312	53	-
	2011	76	48	33	48	62	95	12,350	217	84	-
	Average	***72***	***38***	***21***	***21***	***59***	***46***	***5,994***	***116***	***32***	***-***
Arctic Village	***No Comparable Caribou Harvest Data***										
Anaktuvuk Pass	1990-91	-	-	55	-	-	592	69,964	985	223	-
	1991-92	-	-	51	-	-	545	66,712	940	245	-
	1992	-	74	-	-	-	600	70,222	889	260	82.6%
	1993-94	-	-	43	-	-	574	67,713	846	219	-
	1994-95	-	-	-	-	-	322	43,792	-	-	83.2%
	1996-97	-	-	-	-	-	210	28,587	-	-	90.0%
	1998-99	-	-	-	-	-	500	68,000	-	-	89.5%
	1999-00	-	-	-	-	-	329	44,744	-	-	75.2%
	2006-07	92	61	53	47	63	696	81,490	1,000	299	-
	2011	95	63	53	52	73	616	77,706	914	251	79.2%
	2002-03	-	-	-	-	-	436	59,310	-	-	91.5%
	2001-02	-	-	-	-	-	271	36,910	-	-	75.6%
	2000-01	-	-	-	-	-	732	99,579	-	-	89.1%
	Average	***94***	***66***	***51***	***50***	***68***	***494***	***62,671***	***929***	***250***	***84.0%***

Table J-20
Caribou Harvest Data for All Available Study Years, Caribou Study Communities

Community	Study Year	% of HHs					Estimated Harvest				Percent of Total Harvest
		Using	Trying to Harvest	Harvesting	Giving	Receiving	Total Number	Total Pounds	Average HH Lbs	Per Capita Lbs	
Atqasuk	1996-97	-	-	-	-	-	398	-	-	-	-
	2003	93	66	61	66	66	-	-	-	-	-
	2004	100	79	79	69	74	-	-	-	-	-
	2005	96	70	59	74	63	-	-	-	-	-
	2006	95	67	60	76	57	-	-	-	-	-
	Average	***96***	***70***	***65***	***71***	***65***	***398***	-	***-***	***-***	***-***
Beaver	1985	-	3	0	0	0	0	-	0	0	0.0%
	2010-11	-	-	-	-	-	5	650	-	-	-
	2011	0	0	0	0	0	0	-	0	0	0
	Average	***0***	***0***	***0***	***0***	***0***	***0***	-	***0***	***0***	***0***
Bettles	1981-82	-	-	15	-	5	14	1,788	72	28	10.6%
	1983	-	-	10	-	-	5	644	25	8	4.4%
	1984	-	-	6	-	-	3	451	12	5	4.4%
	1997-98	14	29	0	14	14	0	-	0	0	-
	1998-99	60	40	40	60	20	25	3,276	364	107	-
	1999-00	67	44	44	33	33	21	2,773	173	52	-
	2002-03	58	8	0	12	58	0	-	0	0	-
	2011	63	25	25	25	50	6	780	98	65	37.1%
	Average	***52***	***29***	***18***	***29***	***30***	***9***	***1,214***	***93***	***33***	***14.1%***
Birch Creek	2008-09	25	0	0	25	25	0	-	0	0	-
	2009-10	40	7	0	33	40	0	-	0	0	-
	2010-11	-	0	0	0	8	0	-	0	0	-
	Average	***33***	***2***	***0***	***19***	***24***	***0***	-	***0***	***0***	***0.0%***
Chalkyitsik	2008-09	0	0	0	0	0	0	-	0	0	0
	2009-10	0	0	0	0	0	0	-	0	0	0
	2010-11	0	0	0	0	0	0	-	0	0	0
	Average	***0***	***0***	***0***	***0***	***0***	***0***	-	***0***	***0***	***0***
Circle	2008-09	85	23	3	5	83	1	130	-	1.3	-
	2009-10	7	7	7	0	7	4	400	-	5.9	-
	2010-11	-	0	0	0	0	0	-	-	0	-
	Average	***46***	***10***	***3***	***2***	***30***	***2***	***177***	***-***	***2.4***	***-***

Table J-20
Caribou Harvest Data for All Available Study Years, Caribou Study Communities

Community	Study Year	% of HHs					Estimated Harvest				Percent of Total Harvest
		Using	Trying to Harvest	Harvesting	Giving	Receiving	Total Number	Total Pounds	Average HH Lbs	Per Capita Lbs	
Coldfoot	***2011***	***75***	***50***	***25***	***50***	***50***	***2***	***325***	***65***	***33***	***85.3%***
Eagle	***2004***	***61***	***61***	***14***	***15***	***52***	***19***	***1,957***	***28.8***	***15.2***	***15.7%***
Evansville	1981-82	-	-	15	-	5	14	1,788	72	28	10.6%
	1983	-	-	10	-	-	5	644	25	8	4.4%
	1984	-	-	6	-	-	3	451	12	5	4.4%
	1997	50	14	7	21	50	3	334	19	8	-
	1998	67	25	17	8	58	4	455	33	16	-
	1999	67	25	17	17	50	2	282	22	10	-
	2002-03	58	8	0	12	58	0	-	0	0	-
	2011	77			25	77	-	-	-	-	0.0%
	Average	***64***	***18***	***10***	***17***	***50***	***4***	***565***	***26***	***11***	***4.9%***
Fort Yukon	1986-87	73	13	9	10	64	156	15,587	74	25	2.5%
	2008-09	12	2	1	13	3	3	355	-	1	-
	2009-10	20	10	9	8	18	35	3,518	-	8	-
	Average	***35***	***8***	***6***	***10***	***28***	***65***	***6,487***	***74***	***11***	***2.5%***
Kaktovik	1981-82	-	-	-	-	-	43	-	-	-	-
	1982-83	-	-	-	-	-	160	-	-	-	-
	1983-84	-	-	-	-	-	107	-	-	-	-
	1985-86	-	-	-	-	-	235	-	-	-	-
	1985	95	76	69	67	86	235	27,941	527	149	45.3%
	1986	98	66	60	53	94	178	21,188	378	109	25.2%
	1986-87	-	-	-	-	-	201	-	-	-	-
	1987-88	-	-	55	-	-	185	22,229	383	104	-
	1990	-	-	48	-	-	113	13,453	224	67	-
	1991	-	-	50	-	-	181	22,113	369	94	-
	1992a	96	70	55	53	75	158	19,136	304	99	11.2%
	1992b	-	66	-	-	-	136	15,926	-	-	8.8%
	1994-95	-	-	-	-	-	78	10,608	-	-	8.4%
	2002-03	-	-	-	-	-	112	15,232	-	-	14.5%
	2010-11	94	53	46	51	93	429	58,305	686	203	28.7%
	Average	***96***	***66***	***55***	***56***	***87***	***170***	***22,613***	***410***	***118***	***20.3%***

Table J-20
Caribou Harvest Data for All Available Study Years, Caribou Study Communities

Community	Study Year	% of HHs					Estimated Harvest				Percent of Total Harvest
		Using	Trying to Harvest	Harvesting	Giving	Receiving	Total Number	Total Pounds	Average HH Lbs	Per Capita Lbs	
Nuiqsut	1985	98	90	90	80	60	513	60,021	790	150	37.5%
	1992	-	81	-	-	-	278	32,551	-	-	21.7%
	1993	98	74	74	79	79	672	82,169	903	228	30.7%
	1994-95	-	-	-	-	-	258	30,186	-	-	36.3%
	1995-96	-	-	-	-	-	362	42,354	-	-	23.1%
	1999-00	-	-	-	-	-	413	-	-	112	-
	2000-01	-	-	-	-	-	496	57,985	-	-	31.6%
	2002-03	95	79	63	62	75	586	68,534	692	166	-
	2003-04	99	68	62	65	79	501	58,617	598	147	-
	2004-05	92	70	56	49	58	437	51,129	544	134	-
	2005-06	94	86	76	-	-	562	65,754	707	-	-
	2006-07	97	77	74	66	69	475	-	-	143	-
	2010	100	60	59	97	96	363	-	-	102	-
	2011	99	62	61	81	96	546	-	-	147	-
	2012	97	74	70	81	81	564	-	-	157	-
	2013	95	47	45	49	80	397	-	-	118	-
	2014	90	66	64	67	59	774	105,193	974	253	28.3%
	2015	96	84	78	74	72	628	73,527	728	180	-
	Average	***96***	***73***	***67***	***71***	***75***	***490***	***60,668***	***742***	***157***	***29.9%***
Point Lay	1987	94	72	72	63	73	157	18,418	428	153	17.2%
	2012	93	64	60	71	76	356	48,380	705	186	31.3%
	Average	***94***	***68***	***66***	***67***	***75***	***256***	***33,399***	***567***	***169***	***24.2%***
Stevens Village	2009-10	5	0	0	5	5	0	-	-	0	-
	2008-09	-	0	0	0	10	0	-	-	0	-
	Average	***5***	***0***	***0***	***3***	***8***	***0***	***-***	***-***	***0***	***-***

Table J-20
Caribou Harvest Data for All Available Study Years, Caribou Study Communities

Community	Study Year	% of HHs					Estimated Harvest				Percent of Total Harvest
		Using	Trying to Harvest	Harvesting	Giving	Receiving	Total Number	Total Pounds	Average HH Lbs	Per Capita Lbs	
Utqiaġvik	1987	-	-	26	-	-	1,595	186,669	199	62	30.1%
	1988	-	-	27	-	-	1,533	179,314	191	59	29.2%
	1989	-	-	39	-	-	1,656	193,744	207	64	22.2%
	1992	-	46	-	-	-	1,993	233,206	-	-	17.1%
	1995-96	-	-	-	-	-	2,155	293,094	-	-	24.5%
	1996-97	-	-	-	-	-	1,158	157,420	-	-	13.3%
	2000	-	-	-	-	-	3,359	456,851	-	-	29.3%
	2001	-	-	-	-	-	1,820	247,520	-	-	22.9%
	2002-03	92	61	55	80	78	5,641	659,997	-	123	-
	2003	-	-	-	-	-	2,092	284,444	-	-	22.8%
	2003-04	87	52	45	73	69	3,548	415,116	-	82	-
	2004-05	85	51	48	62	64	4,338	507,546	-	94	-
	2005-06	90	50	47	81	78	4,535	530,595	-	103	-
	2006-07	92	65	59	65	70	5,380	629,460	-	111	-
	2014	70	38	33	38	52	4,323	587,897	371	111	30.6%
	Average	***86***	***52***	***42***	***67***	***68***	***3008***	***370,858***	***242***	***90***	***24.2%***
Venetie	2008-09	98	18	18	65	92	16	2,135	-	14	-
	2009	86	23	14	49	85	105	14,230	151	52	19.1%
	2009-10	39	13	5	25	39	6	556	-	3	-
	2010-11	-	30	15	16	10	44	6,615	-	37	-
	Average	***74***	***21***	***13***	***39***	***56***	***43***	***5,884***	***151***	***26***	***19.1%***
Wainwright	1988	-	-	57	-	-	505	59,085	476.49	117	23.0%
	1989	-	-	66	-	-	711	83,187	699.05	177.75	23.7%
	2009	97	64	61	62	84	1,231	167,356	1,073	284	41.7%
	Average	***97***	***64***	***61***	***62***	***84***	***816***	***103,209***	***749***	***193***	***29.5%***
Wiseman	1991	-	-	-	-	-	10	1,260	-	-	28.2%
	2011	80	80	60	60	20	4	520	104	40	13.6%
	Average	***80***	***80***	***60***	***60***	***20***	***7***	***890***	***104***	***40***	***20.9%***

J.6 REFERENCES

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Appendix K
Environmental Justice

Appendix K. Environmental Justice

Table K-1
Low-income Populations of Kaktovik, Nuiqsut, Arctic Village, and Venetie, Compared with the North Slope Borough and the State of Alaska: 2016

Demographic/Income Characteristic	Kaktovik	Nuiqsut	Arctic Village	Venetie	NSB	State of Alaska
Total Population*	262	446	192	181	9,606	747,894
Persons Employed	62	130	37	39	5,393	353,954
Unemployment Rate	18.4%	19.8%	35.1%	29.1%	10.0%	7.8%
Per Capita Income	$21,925	$24,312	$15,253	$12,695	$49,982	$34,191
Median Household Income	$53,750	$84,464	$25,000	$27,813	$72,027	$74,444
Median Family Income	$66,250	$74,750	$28,750	$24,583	$77,330	$87,365
Percent Low-Income**	3.8%	6.4%	46.7%	53.2%	11.2%	10.1%

*Total population figures shown for the individual communities are 2017 Alaska Department of Commerce, Community, and Economic Development Certified Population figures (https://www.commerce.alaska.gov/dcra/dcraexternal/community/); NSB and Alaska population census estimates for 2016.
** Defined as those persons living below the poverty threshold.
Source: U.S. Census Bureau. 2016. "ACS 2012-2016 5-Year, DP03" unless otherwise noted.
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_DP03&prodType=table

Table K-2
Minority Populations of Kaktovik, Nuiqsut, Arctic Village, and Venetie, Compared with the North Slope Borough and the State of Alaska: 2010

Demographic Characteristic		Kaktovik		Nuiqsut		Arctic Village		Venetie		NSB		State of Alaska	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Race	White	24	10.0%	40	10.0%	7	4.6%	3	1.8%	3,059	32.4%	455,320	64.1%
	Black	0	0.0%	1	0.2%	0	0.0%	0	0.0%	91	1.0%	21,949	3.1%
	American Indian/AK Native	212	88.7%	350	87.1%	135	88.8%	152	91.6%	5,046	53.5%	102,556	14.4%
	Asian	0	0.0%	0	0.0%	0	0.0%	1	0.6%	414	4.4%	37,459	5.3%
	Pacific Islander	0	0.0%	0	0.0%	0	0.0%	0	0.0%	103	1.1%	7,219	1.0%
	Other	0	0.0%	0	0.0%	0	0.0%	0	0.0%	7	0.1%	1,111	0.2%
	Two or more races	3	1.3%	11	2.7%	10	6.6%	10	6.0%	461	4.9%	45,368	6.4%
Ethnicity	Hispanic or Latino	0	0.0%	0	0.0%	0	0.0%	3	1.8%	249	2.6%	39,249	5.5%
	Non-Hispanic or Latino	239	100.0%	402	100.0%	152	100.0%	163	98.2%	9,181	97.4%	670,982	94.5%
Minority Status	Total Minority Population	215	90.0%	362	90.0%	145	95.4%	163	98.2%	6,371	67.6%	254,911	35.9%
	Total Non-Minority Population	24	10.0%	40	10.0%	7	4.6%	3	1.8%	3,059	32.4%	455,320	64.1%
Total Population		239	100.0%	402	100.0%	152	100.0%	166	100.0%	9,430	100.0%	710,231	100.0%

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Appendix L
Economy

Appendix L. Economy

Table L-1
Population of the Potentially Affected Areas, 2010 to 2017

Area	2010	2011	2012	2013	2014	2015	2016	2017	% Change
Communities									
Anaktuvuk Pass	324	323	343	358	325	357	355	355	10%
Atqasuk	233	243	234	248	230	243	221	224	-4%
Utqiaġvik	4,212	4,314	4,434	4,504	4,481	4,548	4,468	4,474	6%
Kaktovik	239	247	244	262	251	243	244	234	-2%
Nuiqsut	402	426	427	452	446	450	470	482	20%
Point Hope	674	668	667	683	654	680	672	677	0%
Point Lay	189	183	196	215	190	211	213	232	23%
Wainwright	556	570	564	541	554	554	557	570	3%
Venetie	166	186	180	197	187	189	192	181	9%
Arctic Village	152	167	177	175	194	180	180	192	26%
North Slope Borough	9,430	9,575	9,710	9,864	9,732	9,887	9,801	9,849	4%
Alaska	710,231	722,388	731,042	735,776	736,906	737,467	739,709	737,080	4%

Source: Alaska Department of Labor and Workforce Development (ADOWLDa), 2018.

Table L-2
Employment and Total Wages in Potentially Affected Communities

Area	Residents Employed		Employment Sector			Total Wages
	#	%	Private	Local	State	
Kaktovik	125	71	41	84	0	$4,958,179
Anaktuvuk Pass	150	68	35	115	0	$4,075,079
Atqasuk	112	76	19	93	0	$3,535,983
Nuiqsut	193	75	73	120	0	$5,919,157
Point Hope	301	67	117	183	1	$8,023,956
Point Lay	106	77	15	91	0	$3,479,948
Wainwright	219	63	72	147	0	$6,659,365
Utqiagvik	2,044	71	875	1,155	14	$111,007,143
Arctic Village	87	78	14	70	3	$1,302,019
Venetie	103	57	23	80	0	$1,643,639

Source: Alaska Labor and Regional Information, (ADOLWDb), 2018.

Table L-3
Kaktovik Resident Employment by Industry and Worker Characteristics, 2016

Industry	Number of Workers	Percent of Total Employed	Female	Male	Age 45 and Over	Age 50 and Over
Natural Resources and Mining	1	0.8	0	1	0	0
Construction	15	12.0	0	15	5	4
Trade, Transportation and Utilities	3	2.4	0	3	1	1
Financial Activities	13	10.4	5	8	7	5
Professional and Business Services	3	2.4	1	2	3	1
Leisure and Hospitality	4	3.2	4	0	2	2
Local Government	84	67.2	47	37	34	26
Other	2	1.6	0	2	0	0

Source: Alaska Local and Regional Information (ADOLWDc), 2018.

Table L-4
City of Kaktovik Fiscal Year 2018 Budget

Source of Revenues	Amount
Locally Generated Revenues	**$1,117,380**
Tax Revenues	$48,000
Service Charges	$22,210
Enterprise Revenues	$840,759
Rentals	$45,000
Leases	$126,411
Sales	$27,000
Other Local Revenues	$8,000
State of Alaska Revenues	**$69,066**
Other Outside Revenues	**$277,457**
Total Operating Revenues	**$1,463,904**
Uses of Funds (Expenditures)	
Administration and Finance	$302,777
Council	$13,111
Pull Tabs	$644,517
Bingo	$162,028
Recreation	$34,014
ASRC Summer Youth Program	$10,000
Others	$297,457
Total Operating Expenditures	**$1,463,903**

Source: Alaska Department of Commerce, Community, and Economic Development (ADCCEDa), 2018.

Appendix M

Approach to the Environmental Analysis

Appendix M. Approach to the Environmental Analysis

M.1 Direct and Indirect Impacts

Direct and indirect impacts are considered in Chapter 3, consistent with direction provided in 40 CFR 1502.16.

Direct Effects – Effects that are caused by the proposed action and occur at the same time and place (40 CFR 1508.8). Examples of direct effects include filling of wetlands through the placement of gravel pads, and direct mortality of wildlife or vegetation.

Indirect Effects – Effects that are caused by an action but occur later in time or are farther removed in distance but are still reasonably likely. Indirect effects may include growth-inducing effects and other effects related to "induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Indirect effects are caused by the proposed action, but do not occur at the same time or place as the direct effects.

Effects are quantified where possible using GIS and other applications. In the absence of quantitative data, best professional judgment prevailed; impacts are sometimes described using ranges of potential impacts or in qualitative terms. Actions may have either adverse or beneficial effects on a particular resource, or both. The standard definitions for terms used in the effects analysis are as follows, unless otherwise stated:

Context – Context describes the area or location (site-specific, local, program area-wide, or regional) in which the impact would occur. Site-specific impacts would occur at the location of the action, local impacts would occur within the general vicinity of the program area, program area-wide impacts would affect the majority/all of the program area, and regional impacts would extend beyond the program area boundaries.

Duration – Duration describes the length of time an effect would occur, either short term or long term. Short term is defined as anticipated to begin and end within the first 5 years after the action is implemented. Long term is defined as lasting beyond 5 years to the end of or beyond the 20-year program time frame.

Intensity –Impacts are discussed using quantitative data wherever possible.

M.2 Cumulative Impacts

The cumulative impact analysis considers impacts of a proposed action and its alternatives that may not be consequential when considered individually, but when combined with impacts of other actions, may be consequential (CEQ 1997). As defined by CEQ regulations (40 CFR 1508.7 and 1508.25[a][2]), a cumulative impact is:

> …the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what

agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The purpose of the cumulative impacts analysis is to determine if the impacts of the actions considered in this EIS, together with other past, present, and reasonably foreseeable future actions, have the potential to interact or accumulate over time and space, either through repetition or combined with other impacts, and under what circumstances and to what degree they might accumulate.

M.2.1 Methodology

The methodology used for cumulative impacts analysis in this EIS consists of the following steps:

- *Identify issues, characteristics, and trends within the affected environment that are relevant to assessing cumulative effects of the action alternatives.* Include discussions on lingering effects from past activities, and demonstrate how they have contributed to the baseline condition for each resource. This information is summarized in **Chapter 3**, Affected Environment.
- *Describe the potential direct and indirect effects of oil and gas exploration activities.* This information is presented in detail in **Chapter 3**, Direct and Indirect Impacts.
- *Define the spatial (geographic) and temporal (time) frame for the analysis.* This timeframe may vary between resources depending on the historical data available and the relevance of past events to the current baseline.
- *Identify past, present, and reasonably foreseeable future actions (RFFAs) such as other types of human activities and natural phenomena that could have additive or synergistic effects.* Summarize past and present actions, within the defined temporal and spatial timeframes, and also identify any RFFAs that could have additive, countervailing, or synergistic effects on identified resources.
- *Use specific methodology to screen all of the direct and indirect effects, when combined with the effects of external actions, to capture those synergistic and incremental effects that are potentially cumulative in nature.* Both adverse and beneficial effects of external factors are assessed and then evaluated in combination with the direct and indirect effects for each alternative on the various resources to determine if there are cumulative effects.
- *Evaluate the impact of the potential cumulative effects and assess the relative contribution of the action alternatives to cumulative effects.*
- *Discuss rationale for determining the impact rating, citing evidence from the peer-reviewed literature, and quantitative information where available.* The term "unknown" can be used where there is not enough information to determine an impact level, and the information cannot be readily obtained in a timely or cost effective manner. However, under CEQ guidelines, the effect of missing information on the decision to be made must be addressed in the EIS.

The analysis also considers the interaction among the impacts of the proposed action with the impacts of various past, present, and reasonably foreseeable future actions as described below:

- *Additive*; the impacts of actions add together to make up the cumulative impact.
- *Countervailing*; the impacts balance or mitigate the impacts of other actions.
- *Synergistic*; the impacts of the actions together is greater than the sum of their individual impacts.

In this EIS, both the time period and geographic scope of the cumulative impacts analysis could vary according to the resource under consideration. Generally, the appropriate timeframe for cumulative impacts analysis spans from the 1970s through full realization of the Reasonably Foreseeable Development Scenario (**Appendix E**), which is anticipated to occur approximately 30 years from the Record of Decision of this EIS. The geographic scope generally encompasses the program area and the North Slope. Details associated with the impact indicators, geographic scope, and analysis assumptions for each resource are found in **Section M.2.2**, below.

M.2.2 Past, Present, and Reasonably Foreseeable Future Actions

Relevant past and present actions are those that have influenced the current condition of the resource. For the purposes of this EIS, past and present actions include both human-controlled and natural events. Past actions were identified using agency documentation, NEPA analyses, reports and resource studies, peer-reviewed literature, and best professional judgment.

The term reasonably foreseeable future action (RFFA) is used in concert with the CEQ definitions of indirect and cumulative effects, but the term itself is not further-defined. Most regulations that refer to "reasonably foreseeable" do not define the meaning of the words but do provide guidance on the term. For this analysis, RFFAs are those that are external to the proposed action, and likely (or reasonably certain) to occur, although they may be subject to a degree of uncertainty. Typically, they are based on documents such as existing plans, permit applications, and fiscal appropriations. RFFAs considered in the cumulative effects analysis consist of projects, actions, or developments that can be projected, with a reasonable degree of confidence that would occur over the next 20 years.

Recent environmental reports, surveys, research plans, NEPA compliance documents, and other source documents have been evaluated to identify these actions. RFFAs were assessed to determine if they were speculative and would occur within the analytical timeframe of the EIS. Projects and activities considered in the cumulative effects analysis are summarized in **Table M-1** and discussed in more detail below.

Table M-1
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Actions/Activities	Description
Oil and Gas Exploration, Development, and Production	• Onshore North Slope • State and Federal waters (Beaufort Sea) • Canadian Arctic	• Geological and geophysical surveys • Infrastructure development • Gravel mining • Geotechnical Borehole Surveys • Construction and maintenance • Exploration activities • Production Wells • Surface, air, and marine traffic • Scientific Research – Avian Studies,	Competitive oil and gas lease sales, lease exploration, and development have occurred across the North Slope. Continued activity is expected. The number of flights by cargo-rated planes associated with oil and gas development tends to increase dramatically during the summer months See below for additional discussion.

Table M-1
Past, Present, and Reasonably Foreseeable Future Actions Considered in the Cumulative Effects Analysis

Category	Area	Actions/Activities	Description
		Bathymetry, Cultural, Fisheries (directly related to oil and gas)	
Transportation (*separate from oil and gas*)	• Surface • Air • Marine	• Roads and vehicular traffic within communities • International marine vessel traffic • Shipping/barging to Kaktovik • Aircraft traffic	Surface, air, and marine transportation services are available within the Program Area. Federal, state, and tribal governments maintain plans for ongoing maintenance and development. See below for additional discussion.
Subsistence Activities	• Kaktovik • Nuiqsut • Arctic Village • Venetie	• Hunting • Trapping • Fishing • Whaling • Sealing • Traveling • Berry Picking	Anticipate a continuation of traditional past and present subsistence practices (See **Section 3.4.3**, Subsistence) See below for additional discussion.
Recreation and Tourism	• Arctic National Wildlife Refuge • Various locations across the North Slope • Beaufort Sea and nearshore areas	• Wildlife/Scenic viewing and photography • Sport/commercial hunting and fishing • Boating and river recreation • Camping • Hiking	Past and present recreational uses of the Program Area are expected to continue (See **Section 3.4.6**, Recreation). Air traffic related to the eco-tourism industry in the Coastal Plain could impact wildlife species. See below for additional discussion.
Scientific Research	• Onshore North Slope • Nearshore waters • OCS waters • Arctic National Wildlife Refuge	• Arctic National Wildlife Refuge studies • Biological, geophysical, archaeological, and socioeconomic surveys • Stock and harvest assessments	Scientific research and surveys have occurred throughout the Program Area and are expected to continue. See below for additional discussion.
Community Development	• Kaktovik • Arctic Village • Venetie • Utqiaġvik • North Slope Borough	• Demographic/population change • Migration • Infrastructure development projects	Anticipate a continuation of infrastructure development projects. See below for additional discussion.

Oil and Gas Exploration, Development and Production

Onshore oil development has been a primary agency of industrial change on the North Slope. Oil and gas exploration activities have occurred on the North Slope since the early 1900s, and oil production started at Prudhoe Bay in 1977. Onshore gas production from the Barrow gas field began over 60 years ago. Associated industrial development has included the creation of industry-supported airfields at Deadhorse and Kuparuk, and an interconnected industrial infrastructure that includes roads, pipelines, production and processing facilities, gravel mines, and docks. Air traffic is also associated with oil and gas development (primarily over the summer months), using small propeller-driven aircraft as well as larger cargo-rated planes (e.g., DC-6 and/or C-130). Oil and gas activities that have occurred in the Beaufort Sea include exploration wells, exploration seismic surveys, geohazard surveys, geotechnical sampling programs, and baseline biological studies and surveys.

Both onshore and offshore reasonably foreseeable future oil and gas activities are considered in this cumulative effects analysis. The discussion does not include small discoveries and undiscovered resources that are unlikely to be developed within the temporal scope of this EIS. The following reasonably foreseeable future onshore oil and gas projects are included in the cumulative effects analysis:

- **SAExploration 3-Dimensional (3D) Seismic Exploration Surveys**: Proposed 3D seismic exploration of the Coastal Plain of the Arctic National Wildlife Refuge would begin in winter 2018/2019. The project will include access to the program area from Deadhorse, storage of fuel, and up to two mobile camps (each capable of housing up to 160 people). Seismic operations would be conducted utilizing 12-15 rubber tracked vibrators and 20,000 to 25,000 wireless autonomous recording devices for each of the two crews. Vibroseis vehicles would be positioned between 41, 25 and 200 feet from an adjacent receiver point on a given line. In a typical square mile, there would be 4 linear miles of receivers and 8 linear miles of source.
- **Liberty Project**: The Liberty Prospect is located 8.85 kilometers offshore in about 6 meters of water, inside the Beaufort Sea's barrier islands. It is 32 kilometers east of Prudhoe Bay and about 13 kilometers east of the existing BP-operated Endicott oil field. Development would include construction of a gravel island for production facilities, including 16 wells. Oil produced from the island would be piped through a subsea pipe to an elevated 1.5-mile long onshore pipeline to a tie in with the existing onshore Badami oil pipeline.
- **Point Thomson**: Point Thomson is a gas condensate field that is currently producing condensate and shipping it via 22-mile oil pipeline to Pump Station 1 on the Trans-Alaska Pipeline. The drillsite and production facilities are located on state onshore lands just west of the Arctic National Wildlife Refuge. The project includes production pads, process facilities, an infield road system, a pipeline, infield gathering lines, and an airstrip.
- **Alpine CD-5**: This Alpine field satellite development drill site is located on Alaska Native village corporation lands near Nuiqsut and is the first commercial oil production from within the National Petroleum Reserve in Alaska (NPR-A). As a satellite to Alpine Central Processing Facility (CPF), CD-5 has only minimal on-site processing facilities but required six miles of gravel road, four bridges, and 32 miles of pipelines including completion of a gravel road and natural gas pipeline from Alpine CPF into Nuiqsut. ConocoPhillips Alaska, Inc. plans to continue drilling an additional 18 wells at CD-5 after the original 15 wells are completed for an eventual total of 33 wells.

- **Nanushuk Project**: The project is located southeast of the East Channel of the Coleville River, approximately 52 miles west of Deadhorse and about 6.5 miles from Nuiqsut (at the southernmost project boundary). The project will include construction of the Nanushuk Pad comprised of Drill Site 1 and a Central Processing Facility, Drill Site 2, Drill Site 3, an operations center pad, infield pipelines, the export/import Nanushuk Pipeline, infield roads, an access road, a tie-in pad, and a potable water system. The project also includes temporary discharges to 5.8 acres of jurisdictional waters of the U.S. for screeding activities at the existing Oliktok Dock.
- **Greater Mooses Tooth**: The Greater Mooses Tooth-1 (GMT-1) project is the first commercial development on federal lands in the NPR-A. The GMT-1 drill site would host 24 additional wells slots for eventual development of two other oil and gas pools in the federally-managed Greater Mooses Tooth Unit. The 7.7-mile-long GMT-1 road, two bridges, and pipelines would connect to Alpine CPF through the existing CD-5 road and pipeline extension. The Greater Mooses Tooth-2 (GMT-2) project is also located on federal lands in the NPR-A. The project could include as many as 48 wells drilled from a 14-acre drill site, 8 miles to the southwest of GMT-1. The proposed 8.6-mile gravel road and pipeline would connect through GMT-1 and on to Alpine CPF through the existing CD-5 extension.
- **Greater Prudhoe Bay/Kuparuk**: This main producing part of the North Slope is expected to have numerous small developments as smaller accumulations of oil are discovered and can be produced using existing infrastructure.
- **Alaska LNG Project**: This development would include a gas treatment plant at Prudhoe Bay; a 42-inch-diameter high-pressure, 800-mi pipeline and eight compressor stations to move the gas to a proposed liquefaction plant at Nikiski, on the Kenai Peninsula. The pipeline would be designed to accommodate an initial mix of gas from the Prudhoe Bay and Point Thomson fields, and room to accommodate other gas fields in the decades ahead. The project is still in preliminary engineering and design stages, and under environmental review.
- **Alaska Stand Alone Gas Pipeline**: This pipeline is envisioned to be a reliable, affordable energy source to Alaskan communities. Production from this project would emphasize in-State distribution, although surplus gas would also likely be condensed and exported. The 727-mile, low pressure pipeline route would generally parallel the Trans Alaska Pipeline System and the Dalton Highway corridor.The pipeline would be underground with elevated bridge stream crossings, compressor stations, possible fault crossings, pigging facilities, and off-take valve locations. A gas conditioning facility would need to be constructed near Prudhoe Bay and would likely require one or more large equipment modules to be offloaded at the West Dock loading facility. Shipments to West Dock would likely require improvements to the dock facilities and dredging would be needed to deepen the navigational channel to the dockhead.

Transportation

In addition to air, land, and marine transport associated with oil and gas activities, there is frequent marine and air traffic associated with coastal communities on the North Slope. It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities will continue. Vessel traffic offshore of the program area can be characterized as traffic to support oil and gas industries, barges or cargo vessels used to supply coastal villages, smaller vessels used for hunting and location transportation during the open water period, research vessels, and a limited number of recreational vessels. Passenger and air cargo flights occur between communities within the Arctic Refuge and across the North Slope, often including several scheduled flights using small

propeller-driven aircraft. Government agencies and researchers often charter aircraft for travel and research purposes. Aircraft traffic is expected to continue; levels of traffic may increase as a result of increased industrial activity, tourism activity, and community development.

Subsistence Activities

Subsistence activities occur throughout the program area. Subsistence hunters primarily use off-highway vehicles, boats, and snowmachines for access. The types of subsistence uses and activities that were described in Chapter 3 (**Section 3.4.3**, Subsistence) are expected to continue into the future. Current and past hunting, gathering, fishing, trapping subsistence activities would be similar in the types of activities and areas utilized by the communities in the analysis area in the future.

Recreation and Tourism

Recreation and tourism activities are generally pursued by non-residents of the program area. With the exception of adventure cruise ships that transit the Beaufort Sea coast in small numbers, there is a concentration of air sightseeing traffic in the Arctic Refuge. The types of recreation and tourism activities that were described in Chapter 3 (**Section 3.4.6,** Recreation) are expected to continue into the future. Current and past sport hunting and fishing, or other recreation or tourism-related activities would be similar in the types of activities and areas utilized by the communities in the analysis area in the future. Transport associated with recreation and tourism activities includes aircraft traffic and powered and non-powered vessel traffic.

Scientific Research

There are scientific research programs that take place within the program area and the Arctic Refuge. These activities involve vessel, air, and overland transport of researchers and equipment, and could contribute to cumulative effects through the disturbance of terrestrial and marine wildlife, impacts to subsistence harvest, or sediment/soil disturbance through biological or chemical sampling.

Community Development

Community development projects in Arctic communities involve both large and small infrastructure projects. For example, the new airport in Kaktovik is a past community development project. Smaller projects resulting from and leading to community growth could further increase demand for public services and infrastructure, such as airport construction upgrades, roads, port and dock construction, telecommunications, alternative energy infrastructure, or telecommunications projects.

M.2.3 Actions Considered But Dismissed

Developments for which a solid proposal has not been submitted or which seem unlikely to occur within the foreseeable future are considered speculative. These may include projects that are discussed in the public arena but are not currently authorized by law or for which there is no current proposal before an authorizing agency. Speculative developments are not considered reasonably foreseeable and are not evaluated as part of the cumulative impacts analysis.

Oil and Gas Activities on Non-Federal Lands

The Coastal Plain is adjacent to State of Alaska lands and contains inholdings owned by Alaska Native Corporations. Although there are no present plans to develop these non-federal lands for oil and gas activity, leasing within the Coastal Plain could result in exploration and development of recoverable

hydrocarbons. Alaskan officials have long argued that the failure to open the Coastal Plain to leasing has denied the State the right to benefit from those largely inaccessible state resources. Future NEPA analyses associated with Coastal Plain leasing activities will consider oil and gas activities on non-federal lands once project-specific details are available.

Arctic Strategic Transportation and Resources (ASTAR)

The ASTAR project is analyzing conceptual regional infrastructure corridors that could meet the needs of the North Slope and Northwest Arctic Borough The current vision of the proposed road network would help to link isolated communities as well as develop oil fields across the region; it does not currently connect to the communities of Arctic Village or Venetie. Benefits of the project could include increased cultural connectivity, reduction in costs to North Slope communities for dry goods, fuel and consumables, decreased cost for rehabilitation of legacy wells in the NPR-A, more efficient development of state and federal hydrocarbon resources, and increased economic activity providing job opportunities for the region. ASTAR is in its preliminary stages; definitive transportation corridor routing would be developed in coordination with the communities and the North Slope Borough.

M.3 Resource Indicators and Assumptions

For organizational purposes, **Chapter 3** is divided into sections by subject area (e.g., water resources, terrestrial mammals, recreation). Though they are described and analyzed in discrete sections, these subjects are dynamic and interrelated. A change in one resource can have cascading or synergistic impacts to other resources. For example, water quality affects fish populations, which in turn influence subsistence harvests, which can have implications for other human outcomes such as health and sociocultural systems. As a result, there is some overlap among the resource sections in **Chapter 3** and the impacts described in one section may depend on the analysis from another section.

During the writing process, subject-level authors collaborated by sharing data and discussing interrelated aspects of the analyses to better capture the interrelated nature of environmental resources. The indicators, analysis areas, and assumptions used for each resource analysis are detailed below.

M.3.1 Climate and Meteorology

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Emissions of greenhouse gases from exploration, production, processing, and transport of well fluids.	Cumulative addition to global atmospheric concentrations of GHGs, potentially causing climate change.	Mass/year (tons/year or metric tons per year) of GHG emissions from petroleum production.

Impact Analysis Area

- *Direct/Indirect*: Coastal Plain program area; development/production GHG emissions estimates.
- *Cumulative*: Coastal Plain GHG emissions compared to Alaska, US, and global total GHG emissions.

Analysis Assumptions

- Assume Coastal Plain oil production begins at 100,000 barrels per day and decreases 8 percent per year over an assumed 40-year production life.

- Assume GHG emissions will be proportional to oil production and use scaling to estimate Coastal Plain development emissions based on GMT2 oil production activities and estimated GHG emissions (from GMT2 DEIS) over an assumed 40-year production life.
- Assume Coastal Plain oil production would not be significantly additive in the global market (i.e., it would not significantly alter global demand and consumption of fossil fuels).

M.3.2 Air Quality

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Leasing	Direct	• Exceedances of NAAQS/AAAQS • Impacts on AQRVs
Fuel combustion in construction equipment, aircraft, vehicles, and machinery such as drill rigs, generators, pumps, and compressor by phase	Indirect, short term (seismic surveys and exploratory drilling) Indirect, long term (buildout of develop units and production)	• Exceedances of NAAQS/AAAQS • Impacts on AQRVs
Construction of ice roads and airstrips to access the CPFs and satellite well pads, as well as construction of the CPFs and satellite pads themselves. Development of gravel pits, which are not included in the 2,000-acre surface disturbance cap, to provide materials for road and pad construction.	Indirect, long term Localized, intermittent, and temporary	• Exceedances of NAAQS/AAAQS
Operation of gravel pits	Indirect, long term Localized, temporary	• Exceedances of NAAQS/AAAQS
Use of roads	Indirect, long term Localized	• Exceedances of NAAQS/AAAQS
Regional sources of air emissions	Cumulative	• Exceedances of NAAQS/AAAQS • Impacts on AQRVs

Impact Analysis Area

- *Direct/Indirect*: Coastal Plain program area
- *Cumulative*: North Slope and federal Class II areas within 125 miles of the North Slope (Gates of the Arctic National Park)

Analysis Assumptions

- Because the location, timing, and level of future oil and gas development on the Coastal Plain is unknown at this time, the BLM has determined that a qualitative assessment is the appropriate level of analysis for this EIS.
- While stipulations determine where and when on-the-ground actions can occur under each alternative, they do not change the overall surface disturbance or level of well development under each alternative, based on the RFD
- Future on-the-ground actions requiring BLM approval would require further NEPA analysis based on specific and detailed information about where and what kind of activity is proposed. Additional site-specific terms and conditions that may be required prior to authorizing any oil and gas activity will be determined as part of this future site-specific NEPA analysis.

M.3.3 Acoustic Environment

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Noise generated from drilling activities • Noise generated from aircraft used in support of fluid minerals activites • Noise generated in the construction of roads, well pads, and other ancillary support activities	Noise disturbance to people and wildlife	• Sound intensity index: the relationship of background noise to an introduced sound level. • Distance to inaudibility • Number of flights/day • Acres closed to leasing and designated NSO

Impact Analysis Area

- *Direct/Indirect*: Coastal Plain program area
- *Cumulative*: Program area, and community of Kaktovik

Analysis Assumptions

- Ambient noise levels approximate 35 dB on the Coastal Plain
- Decibels typically attenuate at a rate of 6 dB per doubling of distance
- Relationships of sound differences and audibility tables tabulated for the GMT2 analysis are generally representative of this EIS/program area

M.3.4 Physiography

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• temporary structures along coast • gravel infrastructure • gravel mines	Coastal erosion and deposition is both direct and indirect impact Gravel infrastructure and mines are direct impact on topography	• Footprint of gravel fill in acres • Size of gravel mines in acres

Impact Analysis Area

- *Direct/Indirect*: Geographic scope for direct impacts is the development footprint for gravel infrastructure and gravel mining.
- *Cumulative*: Program area

Analysis Assumptions

- None

M.3.5 Geology and Minerals

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• gravel fill at locations of important bedrock exposures • development activities have potential to affect the risk of some geologic hazards • no impacts on mineral resources other than petroleum and aggregate resources, which are addressed in other sections	Direct impacts on important bedrock exposures	Discussion is qualitative

Impact Analysis Area

- *Direct/Indirect*: Geographic scope for direct impacts is the development footprint for gravel infrastructure and gravel mining.
- *Cumulative*: Program area

Analysis Assumptions

- Mineral exploration and leasing, other than for petroleum and aggregate, will continue to not be allowed within the program area

M.3.6 Petroleum Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Extraction of oil and gas	Reduction of oil and gas resources available for future use	Percentage of estimated total available reserves removed
Spills of oil and gas and releases of gas to the atmosphere	Loss of oil and gas resources for productive use	Number and volume of spills and gas leaks
Exploration phase	Improved understanding of petroleum oil and gas resources	n/a

Impact Analysis Area

- *Direct/Indirect*: Reduction in oil and gas resources available in the program area.
- *Cumulative*: Program area

Analysis Assumptions

- Oil and gas development will occur under all action alternatives.
- Development will occur in a similar manner and have similar impacts to other North Slope oil and gas developments

M.3.7 Paleontological Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Ground disturbance caused by development or facilities • Gravel fill at locations of bedrock exposures with high PFYC rankings • Gravel extraction • Drilling	If gravel fill is placed over certain bedrock outcrops identified as having high paleontological yield potential, it would make them inaccessible for research. Infrastructure and increased human access would increase access to paleontological resources, which could result in potential looting/removal as well as addition to the identification and scientific body of knowledge of resources in the area.	• PFYC ranking of mapped units • Proximity to mapped units with assigned PFYC rankings

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- PFYC rankings of 3, 4, 5, and U will require further field investigation for individual exploration projects

M.3.8 Soil Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Material resources Extraction Sites • Access roads/pads/staging areas/airstrips (gravel fill or ice) • Off tundra travel • Construction of structures (e.g. pipeline vertical support members, building foundations) • Reclamation of embankments and pads	• Direct surface disturbance to vegetation • Removal of surface insulating organics to cause thaw of frozen soils/destruction of surface landforms • Sand and gravel mining in streams impacts stream structure • Placement of fill for construction of pads/roads • Installation of piling for VSMs and infrastructure foundations	• Acres of disturbance to soil and permafrost • Changes to soil and permafrost from placement of fills for embankments and pad • Changes to erosion of soil from placement of fills for embankments and pad • Fugitive dust extents • Changes in drainage patterns due to permafrost thaw and redirection by embankments

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Up to 200 acres of gravel fill roads and pads will be constructed across frozen soils
- Pads and roads will be constructed to minimize potential thaw of frozen soils (use of thicker embankments or use of insulation)
- Water ponding will occur at base of embankments
- Ice roads will be used to access material sites
- Roads and pads will be reclaimed

M.3.9 Sand and Gravel Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Material resources extraction sites • Ice access roads • Reclamation	• Direct surface disturbance to vegetation; removal of surface insulating organics to	• Acres/volume of material removed

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	cause thaw of frozen soils/destruction of surface landforms • Sand and gravel mining in streams • Placement of fill for construction of pads/roads • Changes in surface drainage/water impoundment • Changes in erosion where surface vegetation removed.	

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Sand and gravel extraction will occur in both uplands and floodplains
- Access roads constructed from ice roads will be required to access material sources
- Material resources are not included in 2,000-acre development limitation

M.3.10 Water Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Sand and Gravel Mining	• Removal of Subsurface Material • Alteration of Surface Water Flow Patterns • Creating of Thaw Bulbs in Permafrost • Placement of Gravel Fill Disrupts Recharge • Increased Sedimentation	• Change to Surface Water Flow • Water Withdrawals • Surface Water Quality • Groundwater
Construction of Gravel Pads, Roads and Air Access Facilities	• Alteration of flow patterns • Oil Spills	• Surface Water Flow • Surface Water Quality • Water Withdrawals • Groundwater • Marine Waters
Installation of Culverts and Bridges	• Alteration to stream hydraulics and drainage patterns • Inundation/starvation of areas	• Surface Water Flow • Surface Water Quality

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Pipeline Construction	• Increased sedimentation during construction • Water contamination due to oil spills.	• Surface Water Flow • Surface Water Quality
Ice Roads and Ice Bridges	• Alteration of natural drainage patterns • Lower lake levels • Ice jamming during breakup	• Surface Water Flow • Surface Water Quality • Water Withdrawals
Barge Docks and Seawater Treatment Plant	• Increased turbidity during construction • Oil spills • Coastal erosion from barge waves	• Marine Waters • Surface Water Flow • Surface Water Quality
Drilling and Operation	• Disturbance of tundra soils • Oil spills • Lower water levels from hydrostatic testing	• Sruface Water Flow • Surface Water Quality • Water withdrawals • Groundwater • Marine Waters

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- The eastern and western program area boundaries follow the Staines River to the west and Aichilik River to the east.
- Impacts are similar to those describe in Greater Mooses Tooth 2 and other North Slope EIS'
- RFD scenarios have similar impact but vary in scale and intensity depending on what project is ultimately developed.
- No specific developments or infrastructure needs have been identified.

M.3.11 Solid and Hazardous Waste

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Management of solid waste generated by the development/operation of facilities • Exploratory drilling • Facility operations • Seismic activities • Road/facility construction	Temporary and permanent storage of solid waste generated from activities (storage area, landfill, or monofill) Air quality impacts from burning refuse Design and implementation of	Solid waste cubic yards per day (based on annual average)—how many acres would be needed for storage area, landfill, or monofill? Solid waste generated per day, calculations for air emissions of burning that much solid waste. Sewage lagoon to be x acres to treat

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Introduction of contaminants including petroleum products caused by • spills • vehicle accidents/rollovers • well blowouts • pipeline leaks • tank overfills Disposal of non-regulated nonhazardous fluids • Injection of nonhazardous fluids through Class I UIC	wastewater facilities Creation of landfill, monofill, other Management of spills Underground injection well Staging and storage areas Underground injection control (Class I or II wells)	y volume per day (based on annual average). Underground injection control wells depth of discharge and quantity (daily or yearly?) Include potential spill volumes? Volume of fuel, other things stored in tanks, and volume of what may flow through pipelines?

Impact Analysis Area

- *Direct/Indirect*: Direct impacts evaluated for the geographic extent of development areas (up to 2,000 acres of development). Indirect impacts area is 0.25 miles outside of the direct impact geographic area.
- *Cumulative*: Cumulative impacts evaluated for the same geographic area as the indirect impacts area.

Analysis Assumptions

- Projects would require SWPPP, SPCC, Solid Waste General Permit, and ODPCP.
- Facilities would require a facility response plan to operate.
- Wastewater design would require approval from DEC.
- Class I or II underground injection wells require a permit/authorization from DEC.
- Storage of greater than 55 gallons (individual container) of oils and other hazardous materials will have appropriate secondary containment.
- BMPs would be implemented to prevent the discharge or accidental spill of petroleum or hazardous materials.
- Controlled access to landfill or sewage lagoon.

M.3.12 Vegetation and Wetlands

Impacts and Indicators – Vegetation

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Seismic exploration: development of rolligon or other off-road vehicle (ORV) trails	Vegetation and plant community alteration from rolligon/ORV traffic	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and EIS-specific development

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
		stipulations. No indicator available to assess possible plant community changes.
Exploration drilling: ice placement for ice roads and pads	Vegetation and plant community alteration from ice placement and operation of ice roads	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and EIS-specific development stipulations. No indicator available to assess possible plant community changes.
Exploration drilling: water withdrawal from lakes to support ice-road and pad construction and other uses	Lacustrine (emergent) vegetation alteration from changing water levels	No quantitative indicator available
Project construction: direct effects of gravel mining	Permanent loss of vegetation types	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and specific development stipulations.
Project construction: direct effects of gravel placement for roads and pads	Permanent loss of vegetation types	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and EIS-specific development stipulations.
Project operations: indirect effects of gravel roads and pads and pipeline corridors	Vegetation and plant community alteration from drifted snow and altered drainage patterns	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and EIS-specific development stipulations. No indicator available to assess possible plant community changes.
Project operations: traffic on gravel roads	Vegetation and plant community alteration from gravel spray and dust fallout	Acreages of vegetation types present within accessible areas for each alternative, stratified by oil potential and EIS-specific development stipulations. No indicator available to assess possible plant community changes.
Project construction and operations: all disturbances with the capacity to introduce non-native/invasive species	Changes to plant community structure with the potential introduction of invasive or noxious non-native plants	No indicator available to assess possible plant community changes.
Project construction and operations: Oil and contaminant spills	Vegetation and plant community alteration from tundra spills	No indicator available to assess possible spill locations in relation to vegetation types.

Impacts and Indicators – Wetlands

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Seismic exploration: development of rolligon or other off-road vehicle (ORV) trails	Alteration of wetland types from rolligon/ORV traffic	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Exploration drilling: ice placement for ice roads and pads	Alteration of wetland types from ice placement and operation of ice roads	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Exploration drilling: water withdrawal from lakes to support ice road and pad construction and other uses	Lacustrine fringe and aquatic wetland alteration from changing water levels	No quantitative indicator available
Project construction: gravel mining	Permanent loss of wetlands and waters of the U.S.	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Project construction: direct effects of gravel placement for roads and pads	Permanent loss of wetlands and waters of the U.S.	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Project operations: indirect effects of gravel roads and pads and pipeline corridors	Alteration of wetland types from drifted snow and altered drainage patterns	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Project operations: traffic on gravel roads	Alteration of wetland types from gravel spray and dust fallout	Acres of wetlands and waters types present within accessible areas for each alternative, stratified by oil potential and EIS specific development stipulations.
Project construction and operations: all disturbances with the capacity to introduce non-native/invasive species	Changes to plant community structure in wetlands with the potential introduction of invasive or noxious non-native plants	No indicator available to assess possible plant community changes
Project construction and operations: oil and contaminant spills	Wetland and plant community alteration from spills on tundra	No indicator available to assess possible spill locations in relation to wetland types

Impact Analysis Area – Vegetation and Wetlands

- *Direct/Indirect*: For the action alternatives, development is permitted and impacts will be assessed within a boundary delineated by EIS-specific development stipulations within the

program area boundary including: no infrastructure, limited infrastructure, and no restrictions. Impacts will be further segregated within three areas of oil potential (high, medium and low).

- *Cumulative*: Program area

Analysis Assumptions – Vegetation and Wetlands

- It was assumed that the final footprint of the anchor development, consisting of 1 CPF, roads connecting to 6 satellite pads, a STP and access road, comprises 750 acres for consideration of direct effects. The indirect area was calculated by buffering the 750-acre gravel footprint by 328 feet for an indirect effects area of 5,630 acres.
- It was assumed that the relative proportions for each area open for development under the alternatives and development stipulations would be affected in similar proportions under the anchor footprint. This was assumed because spatially explicit information about where potential projects might be developed was absent for this Programmatic EIS format.

M.3.13 Fish and Aquatic Species

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Seismic Surveys: Use of rolligons or other off-road vehicles (ORV) Use of vibroseis to image the subsurface	Habitat Alteration - Flow Alteration and Fish Passage: Compaction of ice over and surrounding waterbodies could cause short-term delays in melt. Disturbance, Injury, or Mortality: Increased sound pressure in unfrozen waterbodies (springs) could cause disturbance, injury, or mortality of fish.	Cannot be quantified without an estimate of miles of off road travel.
Water withdrawal from lakes or streams for ice roads, water supply, dust suppression, and other uses.	Alteration or loss of winter and summer aquatic habitat due to water withdrawal activities. May include: ● changes in water levels ● ice compaction ● increased turbidity and other changes in water chemistry ● alteration of water flow during breakup (i.e. seasonal changes to water quantity and quality) ● changes in permafrost or groundwater sources Injury or mortality of fish from entrainment or impingement at water intake.	Types and extent of effects by aquatic habitat (lakes, rivers, springs). Put in context of the scarcity of unfrozen water in winter. Describe stream miles and acreage that could be affected.
Water withdrawal from marine or brackish water (Salinity Treatment Plant)	Alteration or loss of aquatic habitat due to water withdrawal activities- may include changes in local salinity. Injury or mortality of fish from	Type of habitat around STP intake offshore. Changes to water quality baseline

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	entrainment or impingement at water intake.	because of water withdrawal described using the Water Resources EIS section.
Onshore STP facility construction	Alteration of marine or brackish water habitat (sedimentation) during construction phase. Disturbance (temporary alteration of fish migratory route), injury, or mortality of fish due to ice trenching (winter construction) for intake pipe placement.	General footprint of ice trenching with 0.5 mi buffer zone (to be confirmed from water quality or water resource section) to account for: ● Noise effects ● Sedimentation
STP discharge to marine waters (if UIC disposal, then delete this row)	Changes to salinity or other water quality from discharge of brine from saltwater treatment plant.	Changes to water quality baseline described using the Water Resources EIS section. Acres of expected mixing zone.
Gravel Mining for road and pad construction	Alteration or loss of aquatic habitat. Creation of deep aquatic habitat in gravel pits. Changes in water quality, including turbidity. Direct mortality, if mining occurs in waterbodies.	Acres of potential habitat affected by mining (acres of mine sites, assuming all acres would be in rivers), and acres of mine sites in the 50-year floodplain (indirect effects to aquatic habitat).
New gravel roads, pads, culverts, and bridges	Direct aquatic habitat loss. Indirect aquatic habitat alteration from: ● gravel dust and gravel spray ● temporary turbidity and sedimentation during gravel placement, compaction, and grading ● changes in natural drainage patterns (e.g., water impoundment)	Describe direct and indirect effects by aquatic habitat types and their context on the landscape.
Vehicle traffic on ice or gravel infrastructure	Displacement of fish due to blocked fish passage from delayed melt of ice roads or pads and ice plugs in culverts or blockage at bridges. Habitat and water quality alterations due to dust, gravel spray, or sediment runoff from gravel roads.	Acres within 100 m of gravel infrastructure (use linear miles of road and pads) that would be altered by dust, gravel spray. Describe ice infrastructure effects by habitat types and their context on the landscape.
Barging of materials	Disturbance and displacement of fishes during barging activities. Invasive invertebrate and fish species introduction from release of ballast water (could be negated by BMPs). Accidental spills in marine waters.	General description of noise associated with barging. Discussion of BMPs that reduce or negate invasive species introduction (ballast water exchange requirements)

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Barge landing or dock (if this is not included in Alts, then delete row)	Potential alteration of rearing or nearshore foraging habitat. Disturbance and displacement of fishes.	Acres of fill required, type of infrastructure required (overwater structure, sea wall, etc.) Number of barge trips required.
Pipeline construction Trenching for optic cable at stream and road-crossings (assumes trenching in under or adjacent to pipe)	Loss or alteration of habitat.	Describe direct and indirect effects of placing VSMs in the water column by aquatic habitat types and their context on the landscape.
Bridge construction • placement of bridge piers or pile foundations in water • pile driving	Loss or alteration of aquatic habitat from changes in water flow or ice-blockage during spring breakup. Disturbance or displacement of fish during in-water bridge construction (or assume all work in winter and thus no in-water work). Disturbance, injury, or mortality of fish due to noise or vibration during bridge construction.	Describe fish-bearing streams that could require bridges, describe overwintering habitat at or near those waterbodies.
Ice roads and snow management	Displacement of fish or alteration of habitats due to changes in hydrology, melt, and runoff.	Miles of ice road anticipated, if known. General snow management practices.
Potential spills from storage, use, and transport of waste and hazardous materials (including crude oil, fuels, salt water, drilling fluids, and other chemicals). Potential oil spills from wells, pipelines, or other infrastructure.	Habitat alteration if spill enters waterbodies. Injury or mortality of fish from spilled material if it enters waterbodies.	Described on broad level by habitat type (e.g., nearshore, mountain streams, springs) and species affected.
Off-road vehicle activity on tundra (for operations, pipeline maintenance, and spill preparedness and planning)	Habitat alteration due to compression or damage to vegetation resulting in soil exposure and sediment runoff.	Described on broad level by habitat type (e.g., mountain streams, springs) and species affected.

Impact Analysis Area

- *Direct/Indirect*: The program area plus the upstream extent of overwintering habitat for fishes. The nearshore area within the barge route, STP mixing zone, or other connected actions.

- *Cumulative*: Many of the species have life histories that include migrations from the program area west to Barrow, east to the Mackenzie River, and upstream into freshwaters of the entire Arctic Coastal Plain

Analysis Assumptions

- BLM leases are for onshore development; offshore activities could be considered connected actions, but the analysis does not include offshore infrastructure.
- A barge landing or dock will be part of the alternatives.
- There is more fish and aquatic invertebrate use of project area waters than have been confirmed to date. (Assume use over a broader area and by a higher number of species).
- There are contradictions in known ranges for certain species (e.g., Pink salmon, slimy sculpin). The EIS assumes these species are present and use the program area.
- Alternatives will include water withdrawal either from freshwater sources, or more likely, from marine waters via an onshore STP.

M.3.14 Birds

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Seismic surveys by rolligon in winter	Compaction of snow and vegetation, delayed melt in rolligon footprints	Habitat affected (non quantitative)
Gravel placement for roads and pads	Habitat loss	Acres of habitat affected
Gravel placement (roads and pads) and construction of pipeline corridors	Habitat alteration from drifted snow and altered drainage patterns	Acres of habitat affected (use dust fallout buffer)
Road traffic on gravel roads	Habitat alteration from gravel spray and dust fallout	Acres of habitat affected (dust fallout buffer)
Ice placement for ice roads and pads to support wintertime exploration and construction activities	Habitat alteration by ice roads and pads	Habitat affected (non quantitative)
Water withdrawal from lakes to support ice road construction, water supply, dust suppression, and other uses	Habitat alteration by reduced/fluctuating water levels, loss of nesting sites on lakeshores, reduced water quality and fish availability	Describe extent of effect in qualitative terms by aquatic habitat (lakes, rivers, springs)
Water withdrawal from and discharge to the marine environment (STP)	Alteration of aquatic habitat (salinity) for fish (consumed by birds) and potential injury or mortality of fish at intake	Describe changes in water quality (refer to Water Resources section) and area of potential mixing zone

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Gravel mining	Habitat loss. With rehabilitation after abandonment, potential creation of avian habitats previously absent on that site for some species.	Habitat affected (non-quantitative)
Road traffic, air traffic, noise, and human activities	Disturbance and displacement of birds from affected areas	Acres of habitat affected (noise buffer)
Road traffic	Injury and mortality from accidental collisions	Describe potential for vehicle collisions
Use and storage of hazardous materials	Injury and mortality from accidental releases/discharges or insecure containment	Describe potential for accidental exposure
Human activities and waste management	Attraction of predators/scavengers (including increased abundance of some birds) and resulting decrease in survival and nesting success for prey species	Potential impacts to bird populations and predator/prey dynamics
Barging of materials and modules	Disturbance and displacement of birds from nearshore habitats, potential alteration of aquatic habitats by open-water dredging	Describe potential displacement of birds
Human activities, including road and air traffic	Disturbance and displacement of large flocks of staging snow geese	Potential disturbance and displacement (no estimate of distance effect)

Impact Analysis Area

- *Direct/Indirect*: Program area and adjacent marine habitats. Pipeline corridor from Arctic Refuge to Pump Station 1 of TAPS.
- *Cumulative*: North Slope from NPRA east to Arctic Refuge and Canada border.

Analysis Assumptions

- For many actions, impacts can only be described qualitatively either because resource and impact data are unavailable or because project details are uncertain or unknown at the time of this preliminary analysis. For most types of habitat impacts and for some types of behavioral disturbance, (semi-)quantitative estimates of areas affected are possible.
- Habitat Loss and Alteration (including disturbance/displacement): In the absence of spatially specific information, little can be said aside from total areas potentially affected. An upper limit of 2,000 acres is set by the Tax Act.
  - Using a drawing of a standardized anchor field footprint (one CPF and 6 radiating access roads to 6 drill pads, one STP pad and 30-mile access road, totaling 750 acres), estimate the area within 328 feet (for impacts of dust fallout, gravel spray, thermokarsting, and impoundments) and within 656 feet (for impacts of disturbance and displacement).

– Extrapolate to a footprint of 2,000 acres using the proportional increase in area that was calculated for each buffer area that was based on the 750-acre footprint.

M.3.15 Terrestrial Mammals

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Seismic exploration	Direct and indirect effects on vegetation and behavioral disturbance affecting caribou, other ungulates, carnivores (including denning grizzly bears), and small mammals	Area (acres or km²) available for seismic activity under different alternatives (assume no seismic exploration occurs in areas not offered for lease sale?)
Ice placement for ice roads and pads to support wintertime exploration and construction activities	Habitat alteration by ice roads and pads	Area (acres or km²) available for ice road placement by habitat type and alternative (by high, medium, low oil potential?)
Gravel placement for roads and pads	Direct habitat loss	Area (acres or km²) available for gravel road placement by habitat type and alternative (by high, medium, low oil potential?)
Traffic on gravel roads	Habitat alteration from gravel spray and dust fallout	Area (acres or km²) of habitat affected, by habitat type
Gravel mining	Direct habitat loss With rehabilitation after abandonment Indirect habitat loss by disturbance during mining	Area (acres or km²) of habitat affected, by habitat type
Road traffic, air traffic, noise, and human activities	Disturbance and displacement of caribou and other species from affected areas	-Proportion of years areas are used by PCH per season.
Roads and pipelines	Potential obstructions to caribou movements to and from insect-relief habitat Habitat loss due to spills or leaks	-Proportion of CAH using the program area alternatives by season (based on percent of seasonal utilization density from kernel density) -Proportion of years areas are used by PCH by season.
Road traffic	Injury and mortality from accidental collisions	-Qualitative assessment
Use and storage of hazardous materials	Injury and mortality from accidental releases/discharges or insecure containment	-Qualitative assessment
Human activities and waste management	Attraction of predators/scavengers and potential defense of life and	-Qualitative assessment

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	property mortality of grizzly bears Increase in red fox density and decline in arctic fox density	
Roads and pads	Increased/altered access for subsistence hunters	-Qualitative assessment

Impact Analysis Area

- *Direct/Indirect*: Program area (non-marine habitats)
- *Cumulative*: Annual ranges of the Porcupine (PCH) and Central Arctic (CAH) caribou herds.

Analysis Assumptions

- Seismic exploration will not occur in areas not offered for lease sale.
- Subsistence hunting will be allowed along gravel roads.
- Oil development may be more likely to occur in the high oil potential area, less likely to occur in the low oil potential area.
- Zone of influence during calving season: Maternal caribou will be displaced by up to 4 km from roads and pads during and immediately after calving, spanning 3 weeks, based on research in existing North Slope oilfields.
- Roads and pipelines may cause deflections and delays in caribou movements, but those effects can be mitigated by appropriate design features (pipeline height ≥7 ft, pipeline/road separation ≥500 ft) and management of human activities, as developed in the existing North Slope oilfields.
- Occupied grizzly bear dens will be avoided by at least 0.5 mile, as stipulated by the State of Alaska.

M.3.16 Marine Mammals

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Winter activities: seismic exploration; construction and use of ice roads and pads; gravel mining/blasting, hauling, and placement	- Direct habitat loss of polar bear critical habitat and potential maternal denning habitat from gravel mining and placement - Alteration of habitat and temporary loss of use of polar bear critical habitat and potential maternal denning habitat from construction of ice roads and pads - Behavioral disturbance of polar bears, especially denning females	- Acreage of critical and maternal denning habitat affected by seismic exploration. - Apply distance buffer of 1 mile around maternal dens from literature-based assessment of disturbance from equipment operation and noise, and regulatory requirements under current ITRs
Marine vessel traffic during open-water season	- Behavioral disturbance of marine mammals by vessel	- Apply distance buffers along vessel route, from literature-based

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	passage and off-loading during open-water season	assessment of disturbance responses (NO VESSEL ROUTE IDENTIFIED YET)
Traffic, aircraft, noise, and human activities throughout the year	- Behavioral disturbance and displacement from affected areas - Injury and mortality from vehicle strikes	- Apply distance buffer of 1 mile from literature-based assessment of disturbance from equipment operation and noise, and no-disturbance buffer around barrier islands unit of critical habitat
Waste management and use/storage of hazardous materials throughout the year	- Potential attraction and injury/mortality of some polar bears - Injury and mortality from accidental releases/discharges or insecure containment	- Qualitative assessment, considering ROPs for waste handling and human/bear interaction plans

Impact Analysis Area

- *Direct/Indirect*: Program area (including docking structures and adjacent marine habitats) and associated marine transportation routes.
- *Cumulative*: Range of affected species population/stock (e.g., Southern Beaufort Sea stock of polar bears, Western Arctic stock of bowhead whales, etc.)

Analysis Assumptions

- Onshore activities will affect polar bears only, except for those occurring in the vicinity of marine docking structures and module-staging pads at the coast.
- Alternatives will avoid destruction or adverse modification of designated critical habitat (to be addressed by Biological Assessment and Biological Opinion, being prepared separately).
- Maternal den surveys for polar bears will be conducted before any activities occur in the program area, so that occupied dens can be avoided by at least 1 mile during exploration and development.
- Vessel traffic will be restricted to 2 barge landings per year.
- Barge landings may require benthic habitat modification (e.g., dredging or screeding) that has direct (habitat modification) and indirect (loss of habitat use through disturbance from noise and activity) effects.

M.3.17 Landownership and Use

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Areas open/closed to leasing and infrastructure development • Protective measures	• Restrictions on infrastructure development, including type, location, and design	• Acres made available for lease sale where new oil and gas related uses could be developed • Acres where protection

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
that influence the placement or design of uses		measures would influence the design, location, season of use, or type of use
• Landownership changes	• Conveyance of lands out of federal ownership	• Acres of landownership

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Demand for ancillary uses and permits, such as for communication sites, would increase in conjunction with oil and gas development
- There would be no lands conveyed into or out of federal ownership as part of this EIS

M.3.18 Cultural Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Note: Types of impact are not mutually exclusive and may occur across all actions impacting resource.		
Construction Activities • ground disturbance • traffic • human presence • ice roads • water use requirements	• Physical destruction or damage • Removal of the cultural resource from its original location/loss of context • Vulnerability to erosion • Theft/vandalism	• Number of previously documented AHRS and TLUI sites in potentially affected area • Eligibility status of cultural resource sites • Traditional knowledge regarding culturally sensitive areas and traditional use area/sites
Proposed Project Operational Infrastructure • CPFs • Drill rigs and pads • Pipelines/VSMs • Roads • Material sites	• Change to character and setting • Change in use and/or access to traditional sites • Proximity of proposed Project components to culturally sensitive areas	• Same as above
Operation Activities • traffic • human presence • maintenance and security activities • proposed Project	• Introduction of vibration, noise, or atmospheric (*e.g.*, visual, dust, olfactory) elements • Increased access to culturally sensitive areas	• Same as above

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
policies		
Oil Spills	• Physical destruction or damage (including issues with dating damaged artifacts)	• Same as above
General Development	• Loss of cultural identity with a resource • Effects to beliefs and traditional religious practices • Neglect of a cultural resource that causes its deterioration • Lack of access to traditional use areas and effects to broader cultural landscape	• Same as above

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: North Slope

Analysis Assumptions

- All unsurveyed areas of the program area could contain cultural resources. Furthermore, the cursory nature of past surveys efforts likely has not adequately identified cultural resources present.
- Cultural resource sites are assumed eligible for the NRHP unless previously evaluated.

M.3.19 Subsistence Uses and Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Noise, Traffic, and Human Activity • Construction noise • Gravel mining • Air traffic • Ground traffic • Seismic activity • Barge traffic • Drilling noise • Human presence	Reduced resource availability due to changes in resource abundance, migration, distribution, or behavior Increased costs and time associated with harvesting resources Increased safety risks associated with traveling farther to harvest resources Reduced user access due to harvester avoidance of	• Results of wildlife chapters regarding impacts of noise, traffic, and human activity on wildlife • % of harvests coming from study area (where data are available) • % of harvesters using the study area, by resource • Analysis of material and cultural importance of subsistence species • Analysis of AK Wildlife Harvest DB – requires data

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	development/human activity Increased competition with outsider populations	sharing agreement and estimate 1 month or more to develop agreement and analyze data. • Traditional knowledge regarding impacts to subsistence uses, resources, and activities.
Infrastructure • Gravel roads • Ice roads • Pipelines • Gravel pads • Bridges • Gravel Mines • Runways	Loss of subsistence use areas to development infrastructure Physical obstructions to hunters traveling overland Physical obstructions to hunters along the coast due to pipelines Reduced resource availability due to changes in resource abundance, migration, distribution, or behavior Increased costs and time associated with harvesting resources Increased safety risks associated with traveling farther to harvest resources Reduced user access due to harvester avoidance of development infrastructure Increased user access due to use of project roads for subsistence activities Increased competition along new hunting corridors (i.e., roads)	• See Above
Contamination • Oil spills • Air pollution	Reduced resource availability due to changes in resource abundance Reduced resource availability due to harvester avoidance of contaminated resources Reduced user access due to harvester avoidance b/c of	• Results of wildlife chapters regarding impacts of oil spills on wildlife • Results of air quality and public health chapters regarding impacts of air pollution on wildlife and human health • Traditional knowledge

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	concerns about contamination	
Legal or Regulatory Barriers • Security restrictions	Reduced user access due to security restrictions around development infrastructure Reduced user access due to harvester avoidance resulting from concerns about security restrictions/personnel Reduced resource availability due to inability to hunt in or around certain infrastructure	• % of harvests coming from study area (where data are available) • % of harvesters using the study area, by resource • Traditional knowledge
Increased Employment/Revenue	Increased subsistence activity due to cash from employment and other revenue Decreased subsistence activity due to increased employment and resulting lack of time Decreased overall community harvests resulting from lack of time to engage in subsistence activities	• Results of Economy Section • Traditional knowledge
Development – General	Impacts on cultural practices, values, and beliefs	• Traditional knowledge

Impact Analysis Area

- *Direct/Indirect*: All areas used by the subsistence study communities (Kaktovik, Nuiqsut, Arctic Village, and Venetie) for subsistence purposes and the C&T communities located within the GMU subunits crossed by the ranges of the PCH and CAH.
- *Cumulative*: Same as direct/indirect analysis area

Analysis Assumptions

- The impact analysis for subsistence assumes that there will be oil and gas activities comprised of exploration, construction, drilling, and operation similar to other developments on the North Slope

M.3.20 Sociocultural Systems

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Changes in income and employment levels	• No regional or village corporation benefits to many Arctic Village and	• Results of economic chapter regarding potential changes in employment and income

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	Venetie residents • Influx of cash and impacts on social ties and political organizations • Hiring super household hunters • Lack of time for subsistence activities • Increased cash to support subsistence activities	• Results of subsistence chapter • Traditional knowledge
Disruptions to subsistence activities and uses	• Social stresses associated with reduced harvests or changes in effort, costs, and risk • Changes in social ties/organizations resulting from changes in subsistence providers • Loss of traditional use areas and knowledge associated with those places	• Results of subsistence chapter regarding impacts on subsistence • Traditional knowledge
Influx of non-resident temporary workers associated with project	• Conflicts between subsistence users and workers • Discomfort hunting in traditional use areas	• Results of economy chapter regarding outside workers • Results of subsistence chapter • Traditional knowledge
Influx of outsiders into community	• Increased social problems • Lack of infrastructure to support populations • Lack of knowledge/respect of traditional values, history, and beliefs	• Results of recreation chapter • Results of health chapter • Traditional knowledge
Changes in available technologies	• Changes in equipment for subsistence • Changes in transportation routes • Changes in social ties, sharing, and interactions	• Results of economic chapter regarding potential changes in employment and income • Traditional knowledge
Development – General	• Impacts to belief systems • Impacts to cultural identity	• Traditional knowledge

Impact Analysis Area

- *Direct/Indirect*: All of the subsistence study communities (Kaktovik, Nuiqsut, Arctic Village, and Venetie).
- *Cumulative*: Same as direct/indirect analysis area

Analysis Assumptions

- The impact analysis for sociocultural systems assumes that there will be oil and gas activities similar to other developments on the North Slope

M.3.21 Environmental Justice

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Exploration phase activities • Development/construction phase activities • Operations phase activities • Production of oil and gas resources	Direct and Indirect Effects • Subsistence effects • Sociocultural effects • Economic effects • Public health and safety effects	High and adverse effects identified in other resource area analyses that can be shown to disproportionately accrue to minority populations, low-income populations, and/or Alaska Native tribal entities as defined or described under Council on Environmental Quality guidance on the implementation of EO 12898.

Impact Analysis Area

- *Direct/Indirect*: All of the subsistence study communities (Kaktovik, Nuiqsut, Arctic Village, and Venetie).
- *Cumulative*: Same as direct/indirect analysis area

Analysis Assumptions

- Environmental justice impacts would derive from disproportionately high and adverse human health or environmental effects identified in other resource area analyses that would potentially accrue to minority populations, low-income populations, and/or Alaska Native tribal entities. This could include such effects identified in any specific resource analysis, with subsistence, sociocultural, economics, and public health and safety being of primary concern.
- Minority populations and low-income populations would be defined by Council on Environmental Quality guidance on the implementation of EO 12898. The general reference population for the purposes of this analysis will be the State of Alaska.
- Communities specifically included in the local and regional analyses of direct and indirect Environmental justice effects are Kaktovik, Nuiqsut, Arctic Village, and Venetie. These communities have been identified based on the results of the subsistence, sociocultural, economic, and/or public health and safety analyses in conjunction with community demographic information establishing minority and/or low-income population status.

M.3.22 Recreation

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Disturbance within priority recreation areas (direct)	• Change in the quality of the recreation setting and/or user experiences • Displacement of recreation opportunities (from surface disturbance) • Change in the level of access to recreation opportunities, including specially permitted commercial activities • Change in the social setting due to a concentration of users in a smaller area	• Acres of areas made available for lease sales that overlap popular recreation areas and are not subject to NSO stipulations • Acres of surface disturbance that overlap popular recreation areas
• Noise, lights, and human activity (direct/indirect)	• Change in the quality of the recreation setting and/or user experiences • Displacement of recreation opportunities (from surface disturbance)	• Acres where protective measures that minimize impacts on recreation would apply
• Change in resource values (e.g., wildlife) that contribute to the quality of the recreation setting (indirect)	• Change in the quality of the recreation setting and/or user experiences	• Acres where protective measures that minimize impacts on the resource that contribute to recreation settings and experiences would apply

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Current recreation in the planning area would continue.
- The potential for user interactions between all types of users would increase with increasing use.

M.3.23 Special Designations

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
<u>Marine Protected Area</u> Lease Stipulation 4 – Nearshore marine, lagoon and barrier island habitats of	TL stipulation on major coastal waterbodies and coastal islands between May 15 and until the	• Natural Heritage, the primary conservation focus • Natural Heritage, the primary

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
the Southern Beaufort Sea within the boundary of the Arctic National Wildlife Refuge Lease Stipulation 9 – Coastal Area <u>Wild and Scenic Rivers</u> Lease Stipulation 1 – Rivers and Streams <u>Wilderness</u> Lease Stipulation 10 – Wilderness Boundary	later of November 1 or sea ice is within 10 miles of the coast of each season, whichever is later. NSO stipulation on coastal waters, lagoons or barrier islands within the boundaries of the Arctic Refuge Coastal Plain area or 2 miles inland of the coast. NSO stipulation for WSRs in the program area within the setback distances outlined in Chapter 2, Alternatives. NSO stipulation within 3 miles of the southern and eastern boundaries of the Coastal Plain adjacent to the Mollie Beattie Wilderness Area.	conservation focus • ORVs, tentative classification, and free-flowing nature of the river segment or corridor • Changes to the untrammeled and naturalness of the program area, opportunities for solitude or primitive and unconfined recreation, and unique or supplemental values

Impact Analysis Area

- *Direct/Indirect:*
  - MPAs – All marine waters and lagoons located within and off the northern coast of the program area.
  - WSRs – Up to 4 miles of either side of the ordinary high water mark of the eligible or suitable rivers in the program area.
  - Wilderness Characteristics Quality and Values – Program area.
- *Cumulative:*
  - MPAs – All marine waters and lagoons located within the Arctic Refuge and off the northern coast of the program area.
  - WSRs – Up to 4 miles of either side of the ordinary high water mark of the eligible or suitable rivers in the Arctic Refuge.
  - Wilderness Characteristics Quality and Values – All lands in the Arctic Refuge, with an emphasis on the Mollie Beattie Wilderness Area.

Analysis Assumptions

- The MPA in the program area will continue to be managed in accordance with Executive Order 13158 Marine Protected Areas May 26, 2000 and guidance from NOAA on their website: https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/mpaviewer/
- Any eligible or suitable rivers in the program area will be managed under interim protective measures required by the WSR Act and BLM Manual 6400 until Congress makes a decision regarding WSR designation into the NWSRS.

- The BLM would not permit any actions that would adversely affect the free-flowing nature, ORVs, or tentative classification of any portion of the eligible or suitable rivers or actions that would result in the reduction of water quality to the extent that they would no longer support the ORVs.
- The area recommended for wilderness designation would continue to be managed under the minimal management category which would protect its wilderness characteristics in a manner that would not impair the suitability of this area for preservation as wilderness.

M.3.24 Visual Resources

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Surface disturbances, gravel mining, and construction of structures, including pipelines.	New structures and disturbances that do not resemble other elements in an undeveloped landscape.	Changes to the form, line, color, and texture of landform, vegetation, and water, as well as changes to dark skies and wildlife.

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Visual resources in the program area will become more sensitive to visual change; in other words, they will increase in value over time.
- Visual resources will become increasingly important to residents of and visitors to the area.
- Residents and visitors to the program area are sensitive to changes in visual quality and to the overall scenic quality of the area that contributes to living conditions and the visitor experience.
- Activities that cause the most contrast and are the most noticeable to the viewer will have the greatest impact on scenic quality.
- As the number of acres of disturbance increase, the amount of impacts on visual resources will also increase.
- The severity of a visual impact depends on a variety of factors, including the size of a project (such as the area disturbed and physical size of structures), the location and design of structures, roads, and pipelines, and the overall visibility of disturbed areas and structures.
- The more protection that is associated with the management of other resources and special designations, the greater the benefit to the visual resources of the surrounding viewsheds.
- Best management practices and project design, avoidance, or mitigation can reduce but not entirely prevent impacts on visual resources.
- Due to the slow rate of recovery of vegetation and surface conditions, all impacts on visual resources from surface disturbances would be long-term.
- The BLM visual resource management system visual resource contrast rating process (BLM Handbook H-8431-1) will be used for site-specific actions.

M.3.25 Transportation

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Areas available or unavailable for new transportation infrastructure • Seasonal or other timing-related restrictions on access	• Change in the location or type of new transportation infrastructure allowed	• Acres made available for leasing that are not subject to NSO stipulations where transportation infrastructure could be placed • Acres subject to CSU or TLs that could influence the type, location, or design of transportation infrastructure
• New infrastructure limiting public or subsistence access	• Change in the level (increase or decrease) of access for public or subsistence use	• Acres made available for leasing that are not subject to NSO stipulations where transportation infrastructure could increase or decrease the level of access for the public or subsistence user

Impact Analysis Area

- *Direct/Indirect*: Program area
- *Cumulative*: Program area

Analysis Assumptions

- Roads developed for oil and gas development would not be available for public use, but could be seasonally available for subsistence users
- Commercial and casual visits would continue to increase, thereby increasing the demand for public access
- Those seeking access in the decision area have different and potentially conflicting ideas of what should constitute public access on public lands.
- The primary means of access in the decision area would continue to be by aircraft, and to a lesser extent, boat (summer) and snowmachine (winter)

M.3.26 Economy

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
• Exploration phase activities • Development/construction phase activities • Operations phase activities • Production of oil and gas resources	Direct and Indirect Effects • Employment effects • Income effects • Fiscal effects • Effects on public infrastructure and services	Average part-time and full-time jobs (# of jobs) Income (wages in $) Government revenues and expenditures ($) Increase or decrease in economic activity by sector

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
	• Effects on relevant/selected economic sectors	(most likely qualitative)

Impact Analysis Area

- *Direct/Indirect*: Local (Kaktovik), Regional (North Slope Borough), State
- *Cumulative*: Same as direct/indirect

Analysis Assumptions

- *Description of potential oil and gas activities and timeframes under each alternative. This* will include scenarios or assumptions regarding exploration, development, and production activities (i.e., road/ice road construction, on-shore pipelines, processing facilities, camps, etc.) This will be the basis for quantifying the magnitude and scale of economic impacts. [Information will be developed by the Project team based on geological prospects, examples of scenarios from previous EISs/EAs in the North Slope, and subject matter experts]
- *Production volumes by year.* This data will be used to calculate potential royalty payments and other State and the Federal government tax payments. [Information will be developed by the Project team]
- *Oil price forecasts*. This information will be used to quantify potential royalty payments and other fiscal effects of the proposed project. Oil price projections can be obtained from the Alaska Department of Revenue (ADOR Revenue Sources) and from the Energy Information Administration (EIA) Annual Outlook. Alternatively, a constant price scenario could be adopted by the Project team.
- *Construction costs (CAPEX) and construction schedule.* This information will be used to calculate indirect (or multiplier) effects of construction spending as well as potential government revenues including oil and gas property taxes and state corporate income taxes. This data can also be used to estimate direct employment requirements associated with the construction activities. The MAG-PLAN model and data from previous oil and gas development studies in the North Slope can be used to develop rough-order of magnitude cost estimates.
- *Annual operations and maintenance costs of the facilities.* This information will be used to calculate indirect (or multiplier) effects of O&M spending as well as potential government revenues including state corporate income taxes. This data can also be used to estimate direct employment requirements associated with the operations phase (if direct jobs data are not available). The MAG-PLAN model and data from previous oil and gas development studies in the North Slope can be used to develop rough-order of magnitude cost estimates.
- *Tariffs and transportation costs.* This information will be used to calculate netback prices which are the bases for calculating royalty payments. Data on existing tariffs and transportation costs are published by the Alaska Department of Revenue (Revenue Sources Book).
- *Land ownership.* If available, this information will be used to determine potential royalty and right-of-way payments that would accrue to the landowners.

M.3.27 Public Health

Impacts and Indicators

Action Impacting Resource	Type of Impact	Impact Indicator(s) (include unit of measure)
Surface disturbance associated with oil-and-gas development	Impacts to subsistence harvest	• Acres of subsistence harvesting area disturbed • Change in wildlife patterns and avoidance of oil-and-gas development
Oil-and-gas development	Increase in air pollution	• Change in quantity of air pollutants introduced from oil and gas operations
Oil-and-gas development	Increase in water pollution	• Possibility of catastrophic oil spill • Change in quantity of water pollutants introduced from oil and gas operations
Oil-and-gas development	Change in demand for the Kaktovik public health system	• Change in unintentional accidents and injuries • Change in oil and gas revenue for the North Slope Borough and the village of Kaktovik
Oil-and-gas development	Economic Impacts on health	• Change in oil and gas revenue for Kaktovik residents, the North Slope Borough, and the village of Kaktovik
Oil-and-gas development	Accidents/Safety	• Changes in Kaktovik resident travel patterns for subsistence harvest

Impact Analysis Area

- *Direct/Indirect*: Program area, including Kaktovik
- *Cumulative*: Program area, including Kaktovik

Analysis Assumptions

- This EIS analyzes various leasing alternatives and does not analyze specific developments within the area previously referred to as the "1002 area."
- A health impact assessment would be required for specific oil-and-gas development once the lease sale is complete.